SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME LIV JANUARY, 1932 NUMBER 1

CELLULAR STUDIES ON THE THYROID GLAND

GUSTAV ZECHEL, M.D., CHICAGO
Associate in Anatomy and Surgery, College of Medicine, University of Illinois

STUDIES presented in this paper give evidence of the existence of cells in the thyroid gland of the dog, which differ very distinctly from the common cell type found in this gland. Generally the cells appear as small but definite aggregates of several cells among the numerous interfollicular cells; but they also occur in connection with the follicles themselves, sometimes lying just outside, or actually forming a part of their wall, or even located within the follicular lumen and embedded in colloid. These different locations are illustrated in Figures 3 and 10*a*.

The review of the literature disclosed that in 1889 Langendorff described cells in the thyroid gland which differed considerably from the chief cells and called them colloid cells (Kolloidzellen). Since then these cells have been mentioned by very few authors and have hardly been referred to either in the literature or in the textbooks. In the newly published textbook of histology by Maximow and Bloom passing reference is made to cells which seem to be identical with those described in this paper.

This ignored type of cell is distinguished from the common cells of the thyroid in many respects; the cell bodies are larger and in section, appear triangular, multangular, or irregular (Fig. 7*a*, 8) showing marked variations between these forms. When arranged in small groups they flatten each other on adjacent surfaces, hence giving rise to various shapes.

The cytoplasm is uniform in appearance. The affinity of this cytoplasm of the majority of these cells to acid stains is shown by its bright red reaction seen in eosin-hematoxylin preparations; but there are a few of the cells which reveal an attraction for hematoxylin. Their nuclei are spherical, sometimes slightly ellipsoidal, but always are very large relatively, and generally are eccentric in position. The chromatic meshwork of most of them is well differentiated and is conspicuous because of its dark staining, and the lightness of the remaining nuclear substance. Few of the nuclei do not show this contrast because of their even and intensive coloration with hematoxylin (Figs. 4, 5, 6). Hence this distinction places the large thyroid cells in two groups; those with a well defined chromatin network, and those with dense nuclei.

The main features of these large thyroid cells and the other common thyroid cells are compared in Table I. Measurements of the nuclei were taken in order to find their exact difference in size. It is practically impossible to measure exactly the dimensions of the cell itself—which would be the more striking proof—because there are often no boundaries between the adjacent cells and the differences between the two cell types are more striking in the nuclei than in the cell bodies. Table II contains the results of the measurements taken on 100 nuclei of each group. The reader of this table should keep in mind that the

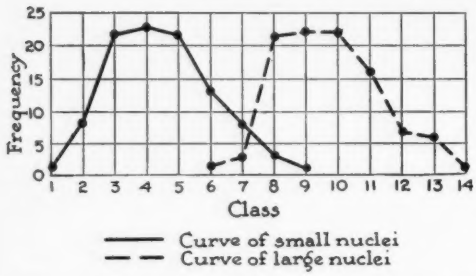


Fig. 1. Graphic representation of the results expressed in Table II.

TABLE I.—MAIN DIFFERENCES BETWEEN THE LARGE AND COMMON THYROID CELLS

	Common thyroid cell	Large thyroid cell
Location	In follicular wall and interfollicular cell groups	Chiefly in interfollicular cell groups. Seldom infollicular wall.
Size	Small	Larger than common thyroid cell.
Shape	Cuboidal or cylindrical	Irregular, round, or multangular.
Size of nucleus	4.0 micra	6.3 micra.
Shape of nucleus	Spherical, mostly ellipsoidal	Mostly spherical, seldom ellipsoidal.
Chromatin network	None or slightly indicated	Very well developed.
Mass ratio between nucleus and cytoplasm	In favor of the nucleus (except in cylindrical cells)	In favor of the cytoplasm.
Frequency of cells representing the two types	"The cell" of the gland	This type represented only by a small number of cells distributed irregularly. It is found mostly in the regenerating gland.

absolute difference of the nuclei is not only expressed by the size but also by the other features computed in Table I. Therefore, it is of no importance that few of the largest individuals in the group of "small" nuclei will be of the same size as the few smallest nuclei in the "large" group. This explains also the crossing of the two curves in Figure 1 which is a graphic illustration of Table I. Tabulating the measurements and calculating the average size of the two types leads to the following

TABLE II.—DIMENSIONAL DIFFERENCES OF THE NUCLEI OF THE TWO CELL TYPES AS DETERMINED BY MEASUREMENT OF 100 NUCLEI IN EACH TYPE

Points on micrometer drum*	Number of nuclei measured (frequency)		Classes of sizes	Distribution of nuclear sizes	
	Small	Large		Small	Large
11	1		1	1	
12	0				
13	3		2	8	
14	5				
15	11		3	21	
16	10				
17	7		4	23	
18	16				
19	8		5	21	
20	13				
21	5		6	14	2
22	9	2			
23	4	1	7	8	3
24	4	2			
25	2	10	8	3	21
26	1	11			
27	1	12	9	1	22
28		10			
29		8	10		22
30		14			
31		9	11		16
32		7			
33		7	12		7
34		0			
35		6	13		6
36		0			
37		1	14		1
	100	100		100	100

*One point on ocular micrometer drum equals 0.218 micra.

results: small nuclei have a diameter of 4.0 micra, and the large nuclei a diameter of 6.3 micra.

The large cells which are located in the interfollicular cell groups often are surrounded

Fig. 2. Drawing of a section through the thyroid of a dog. In the center, a group of large cells between five follicles; the nuclei with a distinct chromatin network; cell boundaries not distinct. Compare the large cells and the common thyroid cells, in regard to color and to ratio between the mass of nucleus and cytoplasm. ×250.

by colloid. Sometimes, indeed, one is unable to distinguish between their cytoplasm and the surrounding colloid. Hence Langendorff

Fig. 3. Composite drawing of different parts of the same section through the thyroid of a dog; demonstrating the relationship between large cells and follicles. *A* shows an insular group of three large cells, *B*, a large cell as part of the wall of a disintegrated follicle, *C*, large cells apparently invading interior of a follicle, *D*, a large cell inside follicle. ×125.

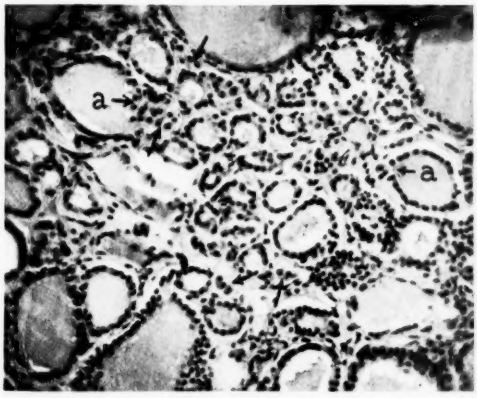


Fig. 4. Photomicrograph of a section through the regenerating thyroid of a dog, 87 days after operation. The part of the follicular wall indicated with the arrow at *a* consists of large cells; immediately beyond the point of the rightmost arrow a small gap. The other arrows indicate groups of large cells scattered in a region of disintegrated and newly-formed follicles. ×160.

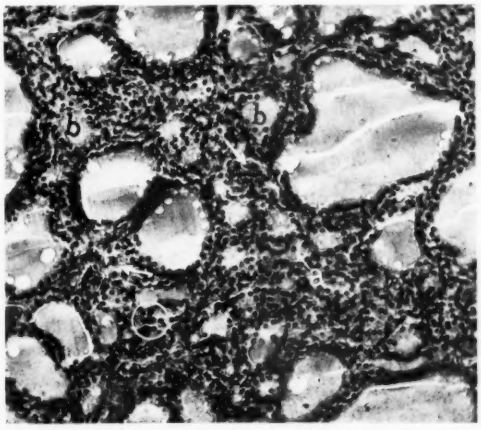


Fig. 5. Photomicrograph of a section through the thyroid of a dog, showing the distribution of the large cells. The arrows not lettered point to cells with well marked nuclear chromatin nets; the ring includes a large cell with compact nucleus; arrow *a* points to a cell which is merged with extrafollicular colloid, the nucleus still remaining visible, *b*, extrafollicular colloid. ×160.

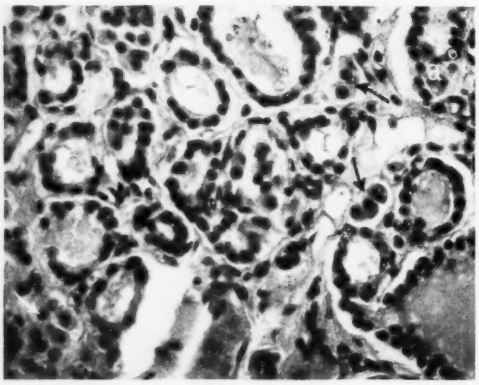


Fig. 6. Photomicrograph of a section through the thyroid of a dog, showing large cells scattered throughout the field as indicated by arrows; at *a* they form a part of a follicular wall. Compare the size of common and large cell types and the ratio between nucleus and cytoplasm in both. ×250.

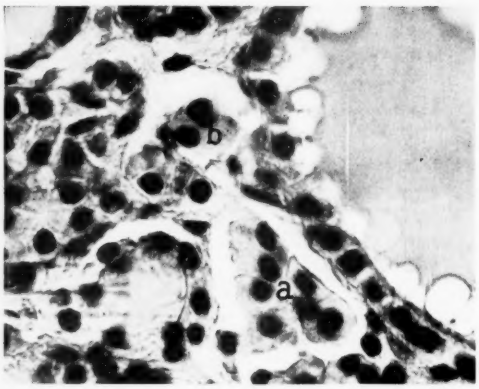


Fig. 7. Photomicrograph of a section through the thyroid of a dog. *a* and *b* represent the groups of several large cells. ×300.

called such cells "colloidal cells." This term is misleading, because there is no proof that the other thyroid cells are not secreting colloid, and not every large cell is in relation with colloid. In some sections, large cells which were a part of the follicular wall are seen to have entered the colloid, leaving a gap in the wall through which other similar cells that were located outside the follicle gain admittance. Perhaps this break in the continuity of the follicle is the initial step in the disintegration of follicles (Figs. 3 and 4, *a*).

Because the large cells are so frequently associated with colloid—even with the free colloid located in the interfollicular spaces—and because a small group of such cells may contain a droplet of colloid in its center, the conclusion is near that they are engaged both in the production of colloid (like the common

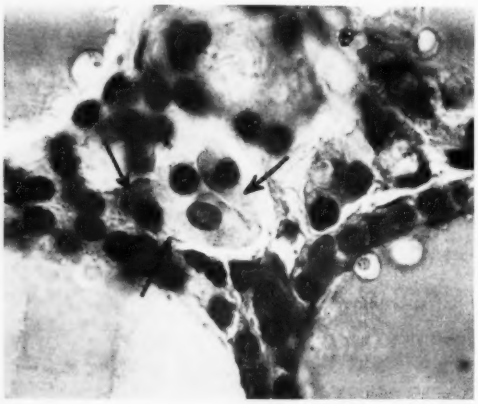


Fig. 8. Photomicrograph of a section through the thyroid of a dog, illustrating a group of four large cells indicated by arrows. The right lower cell, being in focus, exhibits the chromatin network distinctly. ×400.

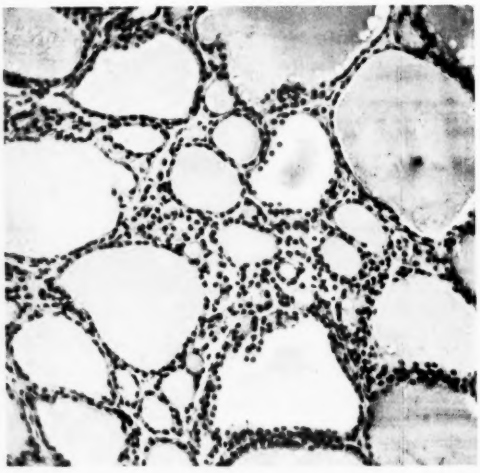


Fig. 9. Photomicrograph of a section through the regenerating gland of a dog, 59 days after the operation. New formation of follicles between larger follicles. For larger magnification of this area, refer to Figure 10. ×170.

thyroid cells) and in the new formation of follicles. In this sense, we may refer to them as "formative" cells. The amount of colloid in contact with the large cells is so small, however, that it is impossible to trace all the colloid back to this type of cell. The greater quantity of colloid is within the follicles, and there is no doubt that the common thyroid cell plays the main rôle in its production.

Although there is a possibility that the large cells degenerate like any other cell, they can not be regarded as representing a degenerating type of cell for the following reasons: (1) they assist in the new formation of follicles; (2) they possess nuclei with distinct chromatin networks; (3) they are more numerous in the regenerating gland than in the resting gland; and (4) they stain well with eosin. In regard to the last point, it may be remarked that cells undergoing hyaline degeneration stain well with eosin, but the large cells of the thyroid show nuclei that are not impaired and the other features mentioned support this conclusion.

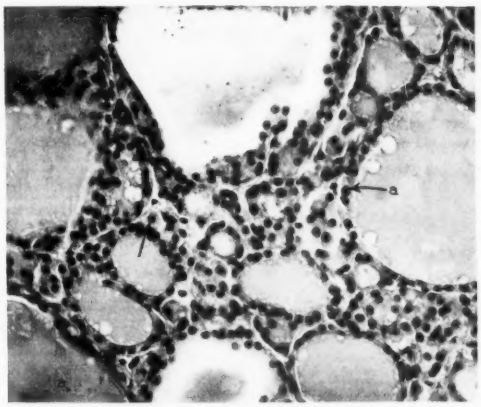


Fig. 10. Photomicrograph of a section through the regenerating gland of a dog 59 days after the operation. Many large cells are observed; *a* points to a large cell which is located within the follicular wall. ×225.

SUMMARY

Two types of cells exist in the parenchyma of the thyroid gland: (1) the common thyroid cell which is the far prevailing type, and (2) the less frequent large cells. The large cells are located more often in the interfollicular cell groups than in the follicular wall, and they occur in greater number in the regenerating than in the resting gland. They may be classified in two groups, those with nuclei possessing a distinct chromatin network, and those with nuclei staining densely and evenly. But the latter compose only a very small group.

In regard to the function it is believed that they are concerned (1) with the formation of new follicles; (2) with the production of colloid; and (3) possibly with the inception of follicular destruction.

TUMORS OF THE BILE DUCTS[1]

JAMES M. MARSHALL, M.D., ROCHESTER, MINNESOTA
Fellow in Surgery, The Mayo Foundation

THERE is probably no position within the human body, outside the central nervous system, where a growth, while yet small, is heralded by more widespread symptoms and is attended by more uniformly disastrous consequences than the lower end of the common bile duct. Tumors of the extrahepatic bile ducts offer one of the most difficult problems of modern surgery, both from the standpoint of diagnosis and of treatment. It is with the hope that careful clinical and pathological study of a group of these cases might lend additional aid in their treatment that this work was undertaken.

MATERIAL FOR STUDY

During the period of 20 years ending January 1, 1930, there were seen, at The Mayo Clinic, 4 cases of benign tumor and 49 cases of primary carcinoma of the extrahepatic bile ducts in which the diagnosis was confirmed by pathologic examination. Operation was performed in all but 4 of the cases. In these 4, complete results of necropsy were available, as well as in 19 of the cases in which operation was performed. The clinical records of the 53 cases, together with the specimens obtained at operation and at necropsy, form the basis of this study.

BENIGN TUMORS

Benign tumors of the extrahepatic bile ducts are rare. Rolleston and McNee, in 1929, mentioned only 10 cases, reports of which they had been able to find in the literature. These tumors are usually papillomatous, fibromatous, or adenofibromatous growths and cause symptoms by mechanical encroachment on the lumen of the involved ducts. Four cases of benign tumors of the ducts have been seen at The Mayo Clinic. Two were adenofibromata of the stump of the cystic duct following cholecystectomy, and the third was a papilloma of the cystic duct obstructing its lumen. For each of the first 2 cases mentioned there were symptoms of obstruction of the common bile duct and obstruction was completely and permanently relieved by removal of the tumor.

Judd and Greene have reported a case of the fourth type of benign tumor of the extrahepatic bile ducts, the so called idiopathic or congenital cyst of the common bile duct, together with a complete summary of 64 cases reviewed from the literature. Tumefaction due to parasitic invasion of the duct has been reported by Podwyssozki and by Devic and Gallavardin.

MALIGNANT TUMORS

Apparently the first case on record in which carcinoma of a bile duct was recognized as a distinct clinical and pathological entity was one of carcinoma of the ampulla of Vater described by McNeal in 1835. Since then, cases have been reported with increasing frequency by Musser, Miodowski, W. J. Mayo, and Outerbridge, as well as by Rolleston and McNee. The condition is not common but is not so extremely rare as it was formerly believed to be. In 4,578 postmortem examinations Kelynack found only 2 cases of primary carcinoma of the bile ducts, and McGlinn found 5 in 9,000 postmortem examinations.

In the period of 20 years from January 1, 1910, to January 1, 1930, 49 cases of primary carcinoma of the extrahepatic bile ducts were seen at The Mayo Clinic and were confirmed by pathological examination. Operation was performed in 45 cases and in the 4 remaining examination was by necropsy. During this period of 20 years more than 22,000 operations of all kinds were performed on the biliary apparatus. In 21 additional cases, carcinoma of the ducts was thought to be present by the operating surgeon, but since tissue was not removed, and pathological confirmation therefore was not had, these cases have been excluded from this series.

Etiology. Until the cause of malignant invasion of the organism is known, the cause of carcinoma in any particular situation cannot be known. Carcinoma of the bile ducts is more

[1]Abridgment of thesis submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Surgery, June, 1930. Submitted for publication March 12, 1931.

common in patients who have passed middle age. Three-fourths of the patients in this series were aged more than 50 years; the youngest was 23 years. Most observers are agreed that the disease is more common in males than in females. In this series 31 (62 per cent) of the patients were males and 18 (38 per cent) were females. Of the 15 patients with carcinoma of the ampulla of Vater 14 were males.

Both in the cases noted in the literature, and in this group, it was found that there were stones in the gall bladder or ducts in less than half. If stone was the principal etiological factor, malignancy might be expected to be more common in females than in males, but the opposite is the case. This is in striking contrast to carcinoma of the gall bladder, which is almost always associated with stones. In this series of 49 cases, gall stones were found in the gall bladder or ducts, or both, in 21 cases. In 5 additional cases there was definite evidence of cholecystitis without stones. Thus it will be seen that in 26 (53 per cent) there was associated disease of the biliary tract, whereas in 23 (47 per cent) the neoplasm was the only lesion present.

Rolleston adhered to the point of view that malignant change seems to start in a benign papilloma and reported a case in support of this. However, most papillomatous growths, when subjected to microscopic study, prove to be malignant. I have been able to find less than 12 cases of benign papilloma of the bile ducts in the literature. MacCarty has reported 2 cases of ulcer at the ampulla of Vater that suggest another possible origin of malignant neoplasm.

Pathology. The most common sites of the tumors are the lower end of the common bile duct, and the ampulla of Vater. In this series of 49, in 4 of the cases the growth was situated in the right or left hepatic ducts; in 2, in the common hepatic duct; and one growth involved the point of union of the two hepatic ducts. In 5, the growth was confined to the cystic duct. There were 11 cases in which the tumor involved the juncture of the cystic, hepatic, and common ducts and 11 in which the common bile duct only was involved. In 15, the carcinoma was at the ampulla of Vater.

Fig. 1. Obstruction of long standing and carcinoma of the left hepatic duct that had spread to cause more recent occlusion of the right hepatic duct. There is extreme hydrohepatosis and marked atrophy of the left lobe of the liver. Jaundice had been present only 2 weeks.

Because of the strategic situation of the growths, and the early appearance of obstruction of the involved duct, most of the tumors are small. Edes has reported a case in which there was a history of obstruction for 15 months, and in which necropsy revealed a carcinoma about 1 centimeter in diameter at the lower end of the common bile duct. Most of the tumors are seen as localized, hard, white growths springing from the epithelial lining of the duct and infiltrating the submucous and connective tissue layers of the wall of the duct with projection into its lumen. Eventually this type of growth extends to involve the serosa, or an adjacent organ such as the liver, gall bladder, pancreas, or a contiguous duct. If the lesion is of the papillomatous type, the growth obstructs the lumen before there is any appreciable infiltration of the wall of the duct.

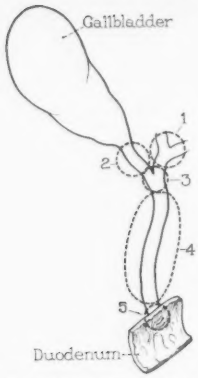


Fig. 2. The various situations of the tumors as classified in the text.

Fig. 3. Large, soft, ulcerating, papillary carcinoma of the ampulla of Vater, projecting into the duodenum. Jaundice had been present 2 months.

This is especially true of tumors in the ampulla of Vater, which frequently project into the lumen of the duodenum and may ulcerate and bleed. L'Esperance, in Ewing's laboratory, observed a case in which a papillary carcinoma, 5 millimeters in diameter, just within the ampulla, had caused a single fatal hæmorrhage.

Microscopically, most of the tumors have the structure of adenocarcinomata composed of columnar epithelial cells in various stages of differentiation. In only 4 of this series of 49 cases, were the carcinomata of the papillary type, with little if any tendency to glandular formation, and these 4 were all tumors in the ampulla of Vater. Ewing emphasized the great amount of fibrous tissue stroma to be seen in most of these tumors, and this, with the fact that a large proportion of the cells is completely differentiated, leads to the conclusion that most of these growths are of a relatively low grade of malignancy.

Metastasis from carcinoma of the bile ducts is not common and usually occurs only late in the disease. In this series, metastasis to one or more organs was present in 12 of the 49 cases; the liver was involved in 9 cases, the regional nodes in 5, the pancreas in 3, and the lungs in 1 case.

The ducts proximal to the obstruction are usually dilated and frequently do not contain bile, but their content is the clear, white, mucous fluid that McMaster and Rous found to be secretion from the mucous glands in the walls of the obstructed ducts. This so called white bile was encountered in 16 of the cases. Varying degrees of hepatic cirrhosis are seen, depending apparently on the duration of the jaundice and the amount of infection present. Surprising degrees of hydrohepatosis are seen in cases of long standing obstruction (Fig. 1). Pancreatitis in these cases is mostly seen as a complicating feature of growths around the ampulla, where the pancreatic duct is obstructed by the tumor.

Symptoms and signs. Because of the position of the growth leading to early obstruction of the duct, the usual clinical picture of malignancy of the ducts is that of obstructive jaundice. The picture varies with the situation of the growth and with the associated conditions, such as cholecystitis, cholangitis, cholelithiasis, and pancreatitis. The course is usually rapid, with jaundice, loss of weight and strength, and death within a period of months.

Jaundice was present in 44 of the 49 cases. In 4 of the remaining 5 cases in which jaundice was not present, the lesion was confined to the cystic duct, and in 1 case carcinoma of the ampulla of Vater was present; cholecystogastrostomy had been performed previously elsewhere. In 20 of the cases jaundice was apparently extreme, constant, and progressive from the onset. In 11 cases jaundice was constantly present, but it varied in degree, as evidenced by the values for serum bilirubin, the color of the stools, and the recovery of bile through drainage tubes. Definitely intermit-

tent jaundice was present in 11 cases; the jaundice entirely cleared up between attacks, but in 7 of these cases there were associated gall stones. In 2 cases the type of jaundice could not be ascertained from the record.

In the cases in which the icterus was constant and obstruction was complete, the average duration of jaundice before admission was 9 weeks; the longest duration was 10 months in 2 cases, in neither of which were stones present. In those cases in which the jaundice was constant but fluctuating, its average duration before examination was 15 weeks and its longest interval 10 months; in this case stones were not associated. In cases in which there was a history of intermittent jaundice, the average interval between the onset of jaundice and admission to the clinic was 22.7 months. However, in every case except one in which the jaundice dated back more than a year, gall stones were present. The exception was a case of carcinoma of the ampulla without associated stones in which there had been recurring jaundice for 18 months.

The degree of jaundice in the series varied from slight to extreme. In the 16 cases in which examination has been made since the van den Bergh quantitative test came into use, the average concentration of bilirubin was 15.7 milligrams in each 100 cubic centimeters of serum; the highest value was 36 milligrams. The reaction was direct in all.

Marked loss of weight was seen in 45 of the cases; the average loss was 22.4 pounds (10 kilograms). In many of the cases this was the outstanding symptom with the exception of the jaundice.

Pain was absent in 15 of the 49 cases during the entire course of the illness. Only 2 of these 15 patients, both of whom had carcinoma of the cystic duct, had associated stones. Of the remaining 34, the onset of the jaundice was painless in 8. Twenty gave histories of definite biliary colic, 5 of whom did not have associated cholecystitis or stones. The 14 remaining described the pain as dull or as aching soreness in the right upper abdominal quadrant.

Pruritus was a prominent symptom in 25 of the cases; in several it was the chief complaint. In 4 cases the itching preceded the jaundice; in 15, the onset was simultaneous with the jaundice; and in 6, it followed the onset of jaundice.

Indefinite gastro-intestinal symptoms were common, particularly late in the disease, and were described as bloating, belching, "indigestion," and intolerance to food. Acholic stools were present in most of the cases at one time or other, and in more than a third diarrhœa was present. Nausea with vomiting was a prominent symptom in 12 cases.

Chills and fever were present in 14 cases, in 5 of which there were associated gall stones. These symptoms were seen in 7 of the 15 cases of carcinoma of the ampulla, a considerably higher frequency than among cases in which growths were in the other situations.

Spontaneous hæmorrhage occurred in 16 cases. Ten patients had cutaneous petechiæ; 2, melena; 2, epistaxis, and 1 patient had metrorrhagia. In 1 of the cases in which operation was not done, hæmorrhage from a benign gastric ulcer was the terminal event.

The gall bladder was palpable in 19 of the cases.

The coagulation time was prolonged in most cases. The average time was 9 minutes; it was more than 10 minutes in 13 cases.

Anæmia was extreme in only a few cases; moderate anæmia of the secondary type was the rule.

DIAGNOSIS

The differential diagnosis of obstructive jaundice is notoriously difficult. Gall stones associated with the malignant lesion lend confusion. Moynihan's often quoted, "No one living is infallible in the differential diagnosis of obstructive jaundice, the diagnosis is always difficult and the chance of a life saved so important that I advise operation in all cases," seems to express the attitude of most surgeons today.

Crohn emphasized the importance of the use of the duodenal drainage tube in these cases. He wrote: "Jaundice, remitting temperature of the 'septic' type, leucocytosis and blood in the duodenal content makes a diagnosis of ulcerating carcinoma of the ampulla." The duodenal drainage tube is used as a routine at The Mayo Clinic to determine the presence or absence of bile in the duodenum.

TREATMENT

In the present state of knowledge, surgical intervention offers the only hope of cure. Most authorities agree that operation should be performed if only for palliation. Erdmann and Heyd have expressed the belief that patients with "malignant jaundice" should be subjected to exploration because there is no absolute assurance that the pre-operative diagnosis is correct and operation will relieve the jaundice, pruritus, and pain, and will prolong the life of the patient in reasonable comfort. Judd wrote: "Too much significance should not be placed on the presenting symptoms in the differential diagnosis because on analysis it will be found that in a high percentage of malignant cases the presenting symptoms will be colic and pain as well as jaundice. In cases of painless jaundice, exploration should be done if the jaundice has persisted long enough to rule out catarrhal cholangitis and if the general condition of the patient warrants the belief that he will withstand the procedure without too great a risk." These patients usually constitute poor surgical risks, chiefly on account of the jaundice and the tendency to bleed. They should be given supportive treatment prior to operation in the form of increased intake of fluid, diet high in carbohydrate, calcium, and transfusions of whole blood.

Because the situation of the tumor determines the surgical procedures that might be attempted in a particular case, it seems best to classify the cases in this regard. From a surgical standpoint it is all important to know whether the gall bladder and cystic duct are in open communication with the proximal or intrahepatic biliary ducts. Obviously it is useless to perform cholecystostomy or cholecystenterostomy if the cystic duct is occluded, or if the obstructing neoplasm is proximal to the cystic duct. Likewise, tumors of the ampulla of Vater might be resected by the transduodenal route whereas those in other situations cannot. Therefore, the cases are divided into 5 groups according to the accompanying diagram (Fig. 2).

In group 1, in which the growth involved the right, left, or common hepatic ducts, the tumor is usually not accessible for removal. I have been unable to find an instance in which radical operation was attempted for such a tumor. Also palliative operations in this group are difficult because of the poor chance of getting drainage proximal to the growth. In this series there were 7 patients in group 1. Radical removal was not attempted in any of the 7 cases; the operations were merely explorations for diagnosis. Six of the patients died within 30 days. The remaining 1, a man with a carcinoma of the right hepatic duct, was living and free from jaundice when he last reported, 7 months after operation. Choledochostomy was performed and a considerable portion of the tumor was removed with a duct scoop and then a long armed T-tube was placed up along the duct for drainage.

Group 2 included those cases in which the tumor was confined to the cystic duct. There were 5 cases in this group. Treatment in all of these was by radical removal of the gall bladder and cystic duct, and in 3 cases by removal of the anterior wall of the common bile duct, adjacent to the cystic duct. All patients survived the operation and lived for an average of 15 months, and one patient was still living and well 2 years and 4 months after operation.

Eleven cases in this series were in group 3, in which the growth involved the juncture of the cystic, hepatic, and common bile ducts. In 8 cases palliative operation was done: cholecystostomy in 3; choledochostomy in 3; and cholecystogastrostomy in 2. Five of the patients died within 30 days, 1 lived 60 days, 1 lived 12 months, and 1 recovered from the operation, left the hospital, and was not again heard from. Three of these patients underwent radical operations, with removal of the growth and involved ducts, and anastomosis of the remaining portions of the ducts. All survived the operations. One patient lived 3 months. I have no details concerning the 2 others.

Group 4 included 11 cases in which the growth was situated in the common bile duct, between the cystic duct and the ampulla of Vater. Nine of the 11 patients were treated surgically. Exploration was done in 2 cases with removal of tissue for diagnosis, palliative drainage of the gall bladder or common bile duct was done in 5 cases, and side-tracking anastomosis with the gastro-intestinal tract

was done in 2 cases. One patient died in the hospital. The average duration of life after palliative drainage was 20 months. One patient lived comfortably 4 years and 3 months after cholecystogastrostomy and one lived more than 2 years after cholecystoduodenostomy.

Group 5 included the cases of carcinoma of the ampulla of Vater (Fig. 3); there were 15 in this series, in 13 of which treatment was surgical. Halsted, in 1899, reported the first radical resection of a carcinoma of the ampulla. He successfully performed transduodenal resection of the ampulla and lower 2 centimeters of the common bile duct and followed it with cholecystoduodenostomy. His patient lived 9 months. Since then the procedure has been modified by different surgeons with a growing tendency toward primary drainage by such an operation as cholecystostomy, choledochostomy, or cholecystogastrostomy for the relief of the jaundice, to be followed later by radical operation (1, 9, 12). In this series radical operation was done four times. Two patients died in the hospital; one patient lived 27 months (transduodenal resection and cholecystoduodenostomy) and one is living and well 2 years after transduodenal resection and cholecystogastrostomy. The best result from palliative operation in this group was obtained by cholecystogastrostomy; the patient on whom it was performed lived 3 years and 4 months.

POSTOPERATIVE COMPLICATIONS

Hæmorrhage was the most common complication; it occurred in 18 cases. In 8 cases hæmorrhage was the chief cause of death, and in 6 cases it was a contributing cause. It was present in 4 of the non-fatal cases. Bronchopneumonia was a factor in 3 of the fatal cases and in 3 in which the patients recovered. Peritonitis was present in 3 of the fatal cases, in all of which the growth was at the ampulla of Vater. Suppurative pancreatitis and pylephlebitis were seen at necropsy in 2 cases, and marked cholangitis in 2 others. Acute tubular nephritis occurred in 3 fatal cases, and in 3 others there was hæmorrhage into the pelvis of the kidney. Hepatic and renal insufficiency, due to cholæmia of long standing, was common both in the fatal and in the non-fatal cases, with high concentration of urea in the blood and partial or complete suppression of urinary secretion.

SUMMARY OF OPERATIVE RESULTS

Forty-five patients were operated on for carcinoma in the various situations named, of which 19 (42.2 per cent) died within 30 days. Twenty-six patients survived the operation for a known average postoperative life of 17.3 months. Three of the series were known to be still living, respectively, 7 months, 20 months, and 34 months after operation. Concerning 6 patients, the ultimate result is unknown.

In this series, patients with co-existent cholecystitis, cholelithiasis, or both, withstood the operations much better than those who had no disease other than the tumor. Of the 26 patients who had carcinoma of the bile ducts, associated with cholecystitis or cholelithiasis, 19 survived the operation and 7 died. In contrast to this, of the 19 patients who did not have associated cholecystitis or stones, 12 died from the operation and 7 survived. No explanation for this can be obtained from analysis of the causes of death in these two groups. Biometric analysis might show that the difference was not significant. However, those patients with infection of the biliary tract may have immunized themselves against infection at the time of operation. Another possible explanation is that the dilated and hypertrophied ducts found in the presence of infection are mechanically more suitable for surgical use than the small, thin walled ducts found in cases without infection.

SUMMARY AND CONCLUSIONS

1. Indications are that benign tumors of the bile ducts are extremely rare, that carcinoma is by far the most common neoplasm of the ducts, and that carcinoma of the bile ducts is more common in males than in females.

2. Gall stones were present in 43 per cent of the cases on which this study was primarily based.

3. Obstructive jaundice has been found in most cases, and may be extreme, fluctuating in severity, or intermittent.

4. The presence or absence of pain seems to be of little, if any, diagnostic significance. Typical biliary colic is not uncommon with tumors of the bile ducts unassociated with cholecystitis or cholelithiasis.

5. The specific cause of obstructive jaundice is not easily diagnosed before operation. Positive diagnosis is rarely possible.

6. Obstructive jaundice is usually a surgical problem, regardless of the type of lesion which causes the obstruction.

7. Surgical treatment should have a favorable effect because significant symptoms bring the patient to the physician early in the course of the disease, and the tumor is small, slow growing, and late to metastasize. Obstructive jaundice usually kills the patient before the tumor itself has passed the stage of operability.

8. Operation on tumors of the bile ducts carries a high mortality because of the tendency to hæmorrhage and the technical difficulties of operation on the biliary tract. Favorable results are attainable.

BIBLIOGRAPHY

1. Cotte, Gaston. Traitement chirurgical du cancer des voies biliaires. Rev. de chir., 1909, xxxix, 1135–1152.
2. Crohn, B. B. The early diagnosis of carcinoma of the bile and pancreatic ducts. Am. J. Surg., 1915, xxix, 270–274.
3. Devic and Gallavardin, Louis. Etude sur le cancer primitif des canaux biliaires. Rev. de méd., 1901, xxi, 557–575.
4. Edes, R. T. Clinical notes and comments: cancer of the extremity of the common bile duct. Boston M. & S. J., 1901, cxliv, 223–226.
5. Erdmann, J. F., and Heyd, C. G. The relief of chronic obstructive jaundice by palliative operations. Am. J. M. Sc., 1916, clii, 174–185.
6. L'Esperance. Quoted by Ewing, 744.
7. Ewing, James. Neoplastic Diseases; A Treatise On Tumors. Philadelphia: W. B. Saunders, 1928, 3d ed., 741–744, 1127.
8. Halsted, W. S. Contributions to the surgery of the bile passages, especially of the common bile duct. Johns Hopkins Hosp. Bull., 1899, cxli, 645–654; 1900, xi, 1–11.
9. Judd, E. S. "Sidetracking" operations in obstructive jaundice. J. Am. M. Ass., 1928, xci, 300–304.
10. Judd, E. S., and Greene, E. I. Choledochus cyst. Surg., Gynec. & Obst., 1928, xlvi, 317–324.
11. Kelynack. Quoted by Mayo.
12. Krausch, W. Die Resektion des mittleren Duodenum. Zentralbl. f. Chir., 1909, xxxvi, 1350–1353.
13. MacCarty, W. C. Studies in the etiology of cancer. Study I. Precancerous conditions. Iowa State M. Soc. J., 1914, iv, 1–11.
14. Mayo, W. J. Malignant disease of the common bile duct. Northwest Med., 1903, i, 173–177.
15. McGlinn, J. A. The relation of gall stones to cancer of the bile tract. New York M. J., 1911, xciii, 519–521.
16. McMaster, P. D., and Rous, Peyton. The biliary obstruction required to produce jaundice. J. Exper. Med., 1921, xxxiii, 731–750.
17. Idem. Physiological causes for the varied character of stasis bile. J. Exper. Med., 1921, xxxiv, 75–95.
18. McNeal. Quoted by Mayo-Robson, A. W., and Dobson, J. F. Diseases of the Gall-Bladder and Bile-Ducts, Including Gall-Stones. New York: William Wood and Co., 1904, 3d ed.
19. Miodowski, Felix. Beitrag zur Pathologie des primaeren und secundaeren Gallengangs-Carcinoms. Arch. f. path. Anat. u. Physiol., 1902, clxix, 117–158.
20. Moynihan, B. G. A. Gallstones and their surgical treatment. Philadelphia: W. B. Saunders, 1905, 2d ed., 458.
21. Musser, J. H. Primary cancer of the gallbladder and bile ducts. II. Primary cancer of the bile ducts. Boston M. & S. J., 1889, cxxi, 581–583.
22. Outerbridge, C. W. Carcinoma of the papilla of Vater. Ann. Surg., 1913, lvii, 402–426.
23. Podwyssozki, W. Ueber die Bedeutung der Coccidien in der Pathologie der Leber des Menschen. Zentralbl. f. Bakteriol., 1889, vi, 41–44.
24. Rolleston, H. D. A papilloma of the bile duct associated with an impacted gallstone. Tr. Path. Soc. Lond., 1894, xlv, 83–84.
25. Rolleston, H. D., and McNee, J. W. Diseases of the liver, gallbladder and bile ducts. London: Macmillan, 1929, 3d ed., 738–758, 884.

THE ASSOCIATION OF THE LIVER IN DISEASE OF THE BILIARY TRACT[1]

E. STARR JUDD, M.D., F.A.C.S., ALLEN C. NICKEL, M.D., AND WILLIAM L. A. WELLBROCK, M.D.,
ROCHESTER, MINNESOTA
Section on Surgical Pathology, The Mayo Clinic

THE peculiar appearance of the surface of the liver frequently observed in the course of operations on the gall bladder and common bile duct is familiar to the majority of surgeons. There is no uniformity of opinion, however, as to the reason for this appearance or for the condition of the underlying hepatic tissue. The association of chronic cholecystitis with superficial scarring of the liver adjacent to the gall bladder usually leads to the loose diagnosis of chronic hepatitis. It is just as difficult for the surgeon to be certain of what is occurring within the liver, from superficial inspection of its capsule, as it is for him to estimate the degree of chronic pancreatitis by palpating the head and body of the organ and in this way determining the degree of its hardness or softness. The comparative rarity with which hepatic lesions of the type under consideration can be examined pathologically is another reason for the lack of understanding of their true nature. However, we now feel that, on the basis of our experience, and with a knowledge of the clinical history, it is possible, with a fair degree of accuracy, to estimate the extent and nature of the hepatic lesions in the majority of cases of surgical biliary disease.

Chronic cholangitis forms the basis of most microscopically recognizable lesions of the liver associated with infection in the gall bladder, with or without obstructive lesions of the common bile duct, but the condition appears in a large number of different forms and under a variety of circumstances. Its early stages are microscopic and the changes are found with difficulty; its later stages may scarcely be distinguished from portal cirrhosis of the hobnail type. We have defined cholangitis as an inflammatory process occurring in and around the walls of the intrahepatic and extrahepatic bile ducts, varying from simple scar of the lining epithelium to marked lymphocytic and polymorphonuclear leucocytic infiltration of the connective tissue of the entire portal spaces. Associated with this there is proliferation of fibrous tissue, leading to tremendous thickening of the walls of the ducts. This description must be modified by the statement that although in most cases the changes are confined to the bile ducts proper they may extend to the intercellular bile canaliculi and may there produce the condition known as biliary cirrhosis.

THE IMPORTANCE OF INFECTION IN THE ETIOLOGY OF HEPATITIS AND CHOLANGITIS

It must be considered that the infection in these cases may be hæmatogenous. The usual conception of chronic cholangitis is that it is the result of obstruction of the common bile duct, with ascending lymphatic infection of the walls of the duct and portal spaces, or that it is the result of ascending infection of the stagnant bile. This is the problem as it presents itself to the surgeon at the time of operation.

At the beginning of this year, we undertook a study of the bacteriology of the liver to see how frequently we would be able to recover organisms from the liver in cases in which there was gross hepatitis associated with gross cholecystitis. It is a well known fact that placing of a free portion of a dog's liver, obtained with strict aseptic precautions, in the general abdominal cavity of an experimental animal regularly causes the death of the recipient animal in from 1 to 3 days. The cause of the death of these animals has been repeatedly discussed by different investigators (Dragstad, Wangensteen, and Mann). Dragstad has recently felt that he has recovered an organism which is responsible for peritonitis, which in turn causes the death of these animals.

The studies which we carried out began with removal of a piece of liver at the time

[1]Read before the Medical Society of the Missouri Valley, Des Moines, Iowa, October 16, 1930.

TABLE I

Source of culture	Cultures made	Positive		Cultures from which organisms were isolated, per cent	
		Number	Per cent	Strepto-cocci	Other bacteria
Liver	37	10	27	14	19
Gall bladder	30	14	47	27	23

Results of cultures obtained from specimens of liver and from surgically resected gall bladders in cases in which operation was performed for disease of the biliary tract.

of operation on the gall bladder. A fair sized piece of liver was taken from the right lobe in certain instances, whereas in other instances a piece of the same size was taken from the left lobe of the liver, at some distance from the gall bladder. The piece of liver was removed at the beginning of the operation before the gall bladder had been disturbed. This was immediately subjected to bacteriological study. This hepatic tissue was cultured, with the use of several different culture mediums. The cultures were incubated at room temperature and at 37 degrees C. They were cultured aerobically, anaerobically, and in an atmosphere of carbon dioxide 10 per cent. They were incubated for at least 2 weeks before being discarded. Cultures of the gall bladder were similarly made.

Cultures of the liver as well as of the gall bladder were made in 30 instances, and in 7 instances, in which the gall bladder was not removed, cultures of the liver only were made (Table I). Therefore, cultures of the liver numbered 37 and of the gall bladder, 30. Of the 37 cultures made from the liver, 27 per cent were positive; 14 per cent yielded streptococci; and 19 per cent, other organisms. From these figures it is evident that a few cultures of the liver contained both streptococci; and other organisms. Of the 30 cultures made from the gall bladder, 47 per cent were positive; 27 per cent contained streptococci and 23 per cent, other organisms. A few of these cultures, also, contained streptococci and other organisms. As has been said, in 7 cases cholecystectomy was not indicated and cultures were made of the liver only. If these are taken as a separate group the results of culture are as follows: 5 were

TABLE II

Strains injected	Source of strain	Rabbits given injections	Percentage of rabbits with lesions	
			Gall bladder	Liver
Streptococci	Gall bladder	16	38	31
	Liver	10	10	10
Diphtheroid organisms	Gall bladder	6	None	None
	Liver	8	None	13
Staphylococci or bacilli	Gall bladder	8	None	None
	Liver	8	None	None

Elective localization of strains isolated from specimens of liver and from surgically resected gall bladders in cases in which operation was performed for disease of the biliary tract.

sterile; 1 yielded a streptococcus; and 1, a Gram-negative bacillus of the colon typhoid group.

The occurrence of streptococci in 27 per cent of the gall bladders agrees with the percentage incidence of cultures of the gall bladder in which streptococci have been obtained previously. These results show that the gall bladder contains bacteria about twice as often as the liver. The streptococci isolated were always of the indifferent, or green-producing, variety. The other bacteria were mainly diphtheroid organisms, staphlococci, and various bacilli. None of the bacilli isolated resembled bacillus welchii in any of its essential properties.

The results obtained by injecting into rabbits the various strains isolated are given in Table II. The streptococci isolated from the gall bladder were selective for the gall bladder of the rabbit but also localized in the liver to a lesser extent. Those isolated from the liver were not as selective in their action. The diphtheroid organisms isolated had practically no selective localizing power, and likewise staphylococci and bacilli did not produce any experimental focal lesions. All of the strains were injected intravenously. The Gram positive bacilli were also injected intraperitoneally in doses of 2 to 3 cubic centimeters of suspension but none of the strains was virulent enough to produce death of the animals.

This bacteriological study of the liver, as well as of the gall bladder, would seem to show

263181

that (1) streptococci were isolated from the gall bladder in the usual percentage of cases and more frequently than they were isolated from the liver; (2) when these streptococci were injected into rabbits they displayed a certain degree of elective localizing power; (3) staphylococci, diphtheroid organisms, and bacilli were isolated less frequently, did not have definite elective localizing power, and were not pathogenic for rabbits when injected in the same dosage as that in which streptococci were introduced; and (4) none of the organisms resembled the description given by Dragstad of the organisms responsible for death of experimental animals from implantation of hepatic tissue.

HISTOLOGICAL STUDIES

Histological as well as bacteriological studies were made of specimens taken from the liver and also of specimens taken from the gall bladder. These studies were made from fresh sections and from fixed frozen sections of the same material as that used for the bacteriological work. Several different stains were used in carrying out this study.

263181

The walls of the gall bladders varied in color and thickness; some were thin, and of a bluish, nearly normal appearance; others were thick, fibrous, and grayish-white. The wall of the gall bladder, as is well known, is composed of several layers. From within outward they are as follows: (1) the mucosa, which consists of a glandular, villous structure, lined with columnar epithelium; (2) the submucosal vascular stroma of connective tissue; (3) the muscularis, which is made of two layers, the circular and the longitudinal intricately arranged, and working in unison for the purpose of expressing the bile; and (4) the serosa or outermost layer consisting of thin endothelial connective tissue which contains a variable amount of fat.

The condition of the walls of the gall bladders varied greatly with the extent of the inflammation. In some it was nearly normal in certain areas except for slight congestion of the capillaries and a little lymphocytic infiltration in the submucosa. In 2 cases the inflammatory process was extensive and severe because of both scattered and collected active lymphocytes and a few plasma cells, in all layers, along with an increase of fibrous connective tissue.

Cholesterosis was present in 5 specimens in this series. However, on microscopic examination, 12 were found to contain a variable amount of this lipoid material in the submucosa of the villi. The lipoid substance was mostly present in the phagocytic cells collected in the villi and was also found in a minute form in the cytoplasm of the epithelium. Stones which occurred in the gall bladder were either of the single, olive-shaped, cholesterol type or of the small, multiple, mulberry variety.

Twenty-four of the gall bladders contained two or more stones of variable color, variety, and shape. The injury to the mucosa varied from a slight brushing off of the villi to almost complete destruction. In many gall bladders there were areas of low glandular epithelium; in other areas, thickened submucosal fibrosis which was covered by a single layer of low columnar epithelium. The amount and extent of inflammatory cellular infiltration varied. In a few gall bladders, the wall consisted of nothing more than dense, fibrous, hyalinized tissue which even contained some deposit of calcium. In those which contained fewer stones than others, and in cases in which the history of disease was of shorter duration, there was much less evidence of previous or present disease. The muscularis in some was destroyed; in others there was hydropic degeneration, with poorly staining cellular nuclei.

In 50 per cent of the gall bladders in this series there were glandular structures within the musculature, which in a few cases extended into the serosa. These were heterotopic glands similar to those in the mucosa, many of which were partly surrounded by lymphocytes. In 2 cases in which stones were not present, these heterotopic glands were present. Their presence may, in some instances, explain the symptoms in a manner similar to that in which glandular structures in the uterine wall may explain symptoms referable to the uterus. They may also be a potential source of adenocarcinoma of the gall bladder.

In some cases the inflammatory reaction in the liver consisted of portal cirrhosis to a vary-

ing degree, together with sclerosis of the blood vessels. In other cases it consisted of perivascular infiltration together with fibrosis or, in some instances, even hyalinization. These processes, in a few cases, extended between the columnar hepatic cells, and the cells occasionally showed some evidence of disease by the presence of poorly staining or small nuclei. In four sections of the liver, there were collections of lymphocytes in the lobules, as additional evidence of hepatic infection. The reaction varied in amount and apparently it was not in direct relationship to the degree of reaction in the gall bladder. This was shown by MacCarty and Jackson in a similar study in 1920.

In all sections of the liver which were stained with Sudan III, fat was present in varying amounts, mostly within the hepatic cells. In these sections which contained a large amount, the fat was seen to occur radially about the central vein. Since there were deposits of lipoid in only twelve gall bladders, there was no indication of direct relationship between deposits of lipoid in the two organs.

SUMMARY

It is certain that this condition of hepatitis or cholangitis occurs routinely in the presence of cholecystitis. It is also true that this condition of the liver exists when recognizable change cannot be made out in the gall bladder or bile ducts. Probably, under these conditions, hepatitis is secondary to infection in some part of the portal system. It is a well known fact that the liver has a marked detoxifying function and that these changes in the hepatic tissue at times may represent the reaction that has taken place as a result of neutralizing either bacterial or chemical toxins that have been brought to the liver by the portal circulation.

We feel sure that hepatitis may occur as a primary condition and that the symptoms which result from it are similar to those of cholecystitis. Furthermore, removal of the gall bladder in these cases of primary hepatitis will relieve the symptoms.

In the group of cases studied, it was clearly shown that bacteria can be found in a certain proportion of these cases. It was difficult, however, to establish the importance of these bacteria from the standpoint of the hepatic change. The virulence of the organisms which were recovered from the liver was not great. Further studies along these lines may possibly tell more concerning the importance of these bacteria.

CHOLECYSTOGRAPHIC CRITERIA IN SURGICAL DIAGNOSIS

An Analysis and Operative Check in 233 Patients[1]

BRUCE L. FLEMING, M.D., Philadelphia

LABORATORY and technical tests designed to aid in diagnosis are frequently introduced to the medical profession with claims of value that are not borne out by subsequent use. Cholecystography seems, in some part at least, to be a welcome exception. Since its introduction in 1924 by Graham, Copher, and Cole it has been very widely used. It is unusual today to have a patient come to operation for biliary tract disease whose cholecystogram has not been previously studied. Though it was primarily introduced as a diagnostic aid without present knowledge of its significance, it has come to be recognized as a test of gall-bladder function, and it has been so considered in this investigation.

Much of the literature on this subject has been contributed by the roentgenologist. We have approached it from the viewpoint of the clinician or surgeon and, therefore, have not been concerned with the technical production of the cholecystograms nor with the interpretation of the films, but rather with the criteria that has been offered by the roentgenologist. It should be known that the oral administration of the dye has been used routinely in our patients, but results have been frequently checked by the intravenous method of administration.

In considering cholecystographic findings one must recall the factors outside the gall bladder and bile ducts which prevent or hinder its visualization. Chief among those found by other observers are: enlargement of the liver (cirrhosis —passive congestion), jaundice, pregnancy after the fifth month, malignant disease of the upper right abdominal quadrant, ascites, or any acute intra-abdominal disease. Roentgenologists have found that in very obese patients it is not always possible to visualize the gall bladder even when normal. This is particularly true when co-operation cannot be secured either through the patient's lack of intelligence or of an understanding of the English language. Colonic irritability or instability is sometimes attended by a failure of the gall bladder to fill after administration of the dye. Lahey and Jordan have recently reported 65 such patients and pointed out that after treatment had been carried out for their colonic symptoms, 44 per cent gave normal cholecystograms. The importance of this observation needs emphasis for symptoms originating in the colon may closely simulate those of biliary tract disease.

Cholecystography depends upon three known functions of the gall bladder: the storage of bile, its concentration therein, and its expulsion on demand into the duodenum. The dye used in this test must have access to the liver which organ secretes it in the bile by means of which it is carried to the gall bladder. Adequate liver function, patent bile ducts, and concentration within this viscus are all essential to visualization. Obviously, unless the gall bladder is visualized, nothing may be learned, by this method of examination, of its size, position, shape, or ability to empty. It must follow, therefore, that the one particular gall-bladder function of which most is learned is the ability to concentrate its fluid contents.

Olch (1927) found that of 52 cases of chronic cholecystitis without stones only 10 showed an abnormal mucosa at operation and in no instance was the mucosa found abnormal microscopically and yet the cholecystograms of all indicated impaired function. Such findings show the difficulty of interpreting function in terms of histopathology. Graham, Lahey, and Kirklin all have remarked upon the difficulty experienced many times in distinguishing macroscopically or microscopically between a normal and an abnormal gall bladder.

Lockwood and Skinner found that in 89.6 per cent of 192 cases having gall stones, the cholecystograms indicated pathological changes in the gall bladder. Case reported that the cholecystographic findings were correct in 96.1 per cent of his cases with gall stones. Ninety-four and one tenth per cent of Wilson's patients with stones showed impaired function of the gall bladder. Most authors commenting on this phase agree that impaired function, as revealed by the cholecystogram, has a higher incidence in the gall bladders containing stones.

Eusterman reviewed 1,510 reports of patients in all of whom positive cholecystograms had been produced. In 41 per cent of these the clinical symptoms or signs of gall-bladder disease were absent or indefinite. He rightly emphasized the need for the realization that cholecystographic criteria must not be accepted as a diagnosis. Murphy, Kirklin, and Graham all found that the

[1]From the Surgical Department, Division B, of the Jefferson Hospital.

gall bladder can recover spontaneously from acute disturbances which lead to its non-visualization by cholecystography, and the latter contends that the cholecystogram, in itself, is therefore not an indication for the removal of the gall bladder.

It has been pointed out by Eusterman and Case that valuable data on the accuracy of the cholecystogram are not available because *all* patients showing impaired gall-bladder function are not subjected to surgery and, therefore, no reliable check can be had. The latter furthermore reminds us that positive cholecystographic findings controlled by operation should also be controlled by an equal number of negative cholecystograms checked by operation. However interesting and useful such information would be, it does not seem essential unless one means to rely entirely on the cholecystogram for diagnosis.

Kirklin reported that the normal cholecystogram is relatively less reliable than the abnormal one. This seems to be in keeping with the findings of most authors. There is need for great care in the interpretation of the normal cholecystogram in patients clinically positive for gall-bladder disease.

The writer has shown that surgically drained gall bladders do not regain normal function as revealed by the cholecystogram, and the latter is of no use in evaluation of symptoms arising subsequently in these patients. A patient may be symptom free with a functionless gall bladder.

Summarizing, we may say cholecystography is a method of studying gall-bladder function. The one function of which it gives most information is the power of concentration of its contents and this is most often found impaired in gall bladders containing stones. Cholecystograms showing a normal response have been found least reliable when attempting to interpret them in terms of symptoms or pathological changes in the organ. No sharp line of demarcation between the normal and abnormal gall bladder has been determined by the histopathologist or surgeon. Data are not available in which equal numbers of positive and negative cholecystograms have been checked by operation. Cholecystographic criteria is not to be accepted as a diagnosis nor is it an indication, in itself, for removal of the gall bladder. A knowledge of the extracystic factors that may interfere in the production of a cholecystogram is essential in interpreting reports.

In this investigation we have attempted to correlate cholecystographic criteria of patients, operated on primarily for biliary tract disease, with the findings of the surgeon and the histopathologist. We were interested also in determining whether there may be disturbance of a gall bladder sufficient to lead to a positive clinical diagnosis, and impaired function detectable by cholecystography without pathological change in the organ.

At the outset it was our intention to make use of 200 consecutive cases operated on from the surgical wards of the Jefferson Hospital for gall-bladder disease. Additional records have become available and to this group 33 were added, making in all 233 consecutive cases. It was necessary to omit 14 records because their information was inadequate. It is important to note that all patients considered herein were operated on primarily for biliary tract disease and with that clinical diagnosis. The findings by cholecystogram as reported from the roentgenological department have been compared with the surgeon's findings at operation and, when available, with the histopathological reports.

CHOLECYSTITIS WITH STONES

TABLE I.—CHOLECYSTOGRAPHIC FINDINGS[1]

	With stones	Without stones	Total
Gall bladder non-functioning or "not visualized"	20	71	91
Gall bladder poor functioning or poor visualization and poor emptying	40	57	97
Normal gall bladder	2	29	31
Total	62	157	219

[1] All patients operated on primarily for biliary tract disease.

Gall stones were found at operation in 119 patients. Sixty of these were reported in the cholecystographic criteria but 94.4 per cent of these stone cases showed impaired or entirely lost gall-bladder function (Table I). Of the 219 patients considered 93+ per cent were found by the surgeon to have diseased gall bladders. It is not to be inferred that the final pre-operative diagnoses were not frequently influenced by the cholecystographic findings. The latter, however, were an adjunct to the clinical diagnosis as is evidenced by the fact that 13.3 per cent gave normal cholecystograms.

NORMAL CHOLECYSTOGRAMS IN CLINICALLY POSITIVE GALL-BLADDER DISEASE

Eighty-eight and two-tenths per cent (180 of 204) of the gall bladders found diseased by the surgeon had impaired function. Eleven and seven-tenths per cent (24 of 204) gave normal cholecystographic response.

These findings indicate that a gall bladder may be diseased sufficiently to give rise to symptoms leading to a positive clinical diagnosis and such diagnosis be confirmed at operation and still the cholecystographic response be normal. In those in which the diagnosis was confirmed by the histopathologist, 11.9 per cent (14 of 117) had normal function. There were 188 patients having clinically positive gall-bladder disease plus disturbed function as revealed by the cholecystogram, and of these only 8, or 4.2 per cent, were found normal by the surgeon. Of 8 gall bladders found normal by the surgeon, 7, or 87 per cent, gave normal cholecystograms. Four normally functioning gall bladders containing stones were reported.

CHRONIC CHOLECYSTITIS WITHOUT STONES

Of 78 patients found to have chronic cholecystitis without stones, 17, or 28 per cent, all checked at operation and, by the histopathologist, gave normal cholecystograms. This indicates quite clearly that the group of patients that presents the greatest difficulty to the clinician and surgeon in clinical diagnosis is the same group in which the gall bladders show the greatest variation in function.

TABLE II.—SURGEON'S FINDINGS AT OPERATION[1]

	Gall bladder not visualized	Gall bladder poorly visualized or abnormal	Normal dye response	Total
Diseased with stones	65	54	7	126
Diseased without stones	23	38	17	78
Normal	3	5	7	15
Total	91	97	31	219

[1] All patients operated on primarily for biliary tract disease.

The surgeon found 78 diseased gall bladders without stones (Table II). Seventy-eight and two-tenths per cent of these had disturbed function as contrasted to 94.4 per cent of the patients with stones. Twenty-nine and five-tenths per cent of the gall bladders were *not visualized* as contrasted to 51.6 per cent in those having stones. Forty-eight and seven-tenths per cent had *impaired function* as contrasted to 42.8 per cent in those with stones but 21.8 per cent had normal functioning gall bladders while only 5.5 per cent were found in patients with stones.

There are 120 patients on whom histopathological reports are available (Table III). In the group showing impaired gall-bladder function

TABLE III.—HISTOPATHOLOGICAL FINDINGS

	Gall bladder not visualized	Gall bladder abnormal or poorly visualized	Normal dye response	Tota
Abnormal with stones	34	22	4	60
Abnormal without stones	12	35	10	57
Normal without stones	0	0	3	3
Total	46	57	17	120

[1] 120 patients operated on primarily for biliary tract disease.

100 per cent were found abnormal by the pathologist. The only gall bladders reported normal by the pathologist were from the group showing normal dye response.

SUMMARY AND CONCLUSIONS

Correct pre-operative clinical diagnosis as checked by the surgeon at operation was 93 per cent. Eighty-eight and two-tenths per cent found by surgeon to have gall-bladder disease had disturbed gall-bladder function revealed by the cholecystogram. Eleven and seven-tenths per cent had normal gall-bladder function. The pathologists found no normal gall bladders in a smaller number (120) with clinically positive gall-bladder disease and impaired function revealed by cholecystography.

Ninety-four and four-tenths per cent of the patients with stones had impaired or lost gall-bladder function. Stones were found by cholecystography in 50 per cent of all patients with gall stones.

In the patients found to have gall-bladder disease *without* stones, the function was not only disturbed *less frequently* but to a *less degree*. Of these non-stone cases 28 per cent had normally functioning gall bladders. These patients represent the group (chronic cholecystitis without stones) that likewise presents the greatest difficulties in clinical diagnosis. In cholecystography, as in any other functional test or laboratory determination, a knowledge of limitations is as essential to usefulness as a knowledge of possibilities.

Of all patients having clinically positive gall-bladder disease and disturbed function as revealed by the cholecystogram, only 4.2 per cent were found normal by the surgeon. This emphasizes the value of positive clinical opinion in conjunction with positive cholecystographic findings.

A normal cystogram from a patient suspected of having gall-bladder disease is not to be inter-

preted as trustworthy evidence against the presence of such disease.

Cholecystographic criteria in diagnosis are adjuncts and are of value only when interpreted in conjunction with the clinical history and findings, and after all known extracystic factors that may interfere in its production, have been eliminated.

The author is indebted to Drs. Edward J. Klopp and Willis F. Manges for valuable suggestions.

BIBLIOGRAPHY

1. Case, J. T. The interpretation of cholecystographic findings; operative check in 277 cases. Ann. Surg., 1929, lxxxix, 222.
2. Eusterman, G. B. Limitations of cholecystography with which physicians should be familiar. J. Am. M. Ass., 1928, xc, 194.
3. Fleming, B. L. An investigation of the functions and symptoms of the surgically drained gall bladder. Ann. Surg., 1931, xciii, 730–735.
4. Graham, E. A. Uses and abuses of cholecystography. Southern M. J., 1929, xxii, 10–15.
5. Kirklin, B. R. Cholecystography; general appraisal. Arch. Surg., 1929, xviii, 2246–2256.
6. Lahey, F. H. Surgical conditions of the biliary tract. Ann. Surg., 1929, xc, 373–386.
7. Lahey, F. H., and Jordan, S. M. Management of biliary tract disease. Am. J. Surg., 1931, xi, 1.
8. Lockwood, I. H., and Skinner, E. H. Cholecystography. An analysis of 1500 cholecystographic examinations with correlated clinical and laboratory findings with special reference to pernicious anemia, myocardial degeneration, infectious arthritis, and gastric acid content. Radiology, 1928, xi, 7–12.
9. Murphy, G. T., and Higgins, G. M. The emptying of the gall bladder following restoration from acute experimental cholecystitis. Arch. Surg., 1930, xx, 756.
10. Olch, I. Y. Chronic cholecystitis. An analysis of 100 consecutive cases diagnosed with cholecystography and treated by cholecystectomy, in which the end results were investigated. Am. J. M. Sc., 1927, clxxiii, 368.
11. Wilson, R. T. Clinical value of cholecystography. Southern M. J., 1930, xxiii, 345–349.

PRIMARY IDIOPATHIC ABSCESS OF THE LIVER

CLAUDE F. DIXON, M.D., F.A.C.S., Rochester, Minnesota
Division of Surgery, The Mayo Clinic
AND
GEORGE T. MURPHY, M.D., Rochester, Minnesota
Fellow in Surgery, The Mayo Foundation

THE etiology of idiopathic abscess usually is obscure. However, abscess of the liver of bacterial cause may take origin in the field of drainage of the portal vein. In addition, infection may enter the liver by way of the bile ducts, hepatic artery, and veins; direct extension may be by way of the lymphatic channels and by direct trauma. However, bacteria carried to the liver do not always undergo proliferation, but often, fortunately, are destroyed by the hepatic tissue.

Eliason has called attention to the fact that the incidence of hepatic abscess following appendicitis varies from 0.1 to 0.4 per cent. He has expressed the firm belief that the most important cause of hepatic abscess is suppuration of the appendix, inasmuch as nearly 50 per cent of all pyogenic hepatic abscesses may be said to have their origin at this focus. The sequence of acute suppurative appendicitis, complicated by thrombosis in the mesoappendix, and followed by infectious embolism through the portal system, later to terminate in an abscess of the liver, has been well established. However, ruptured duodenal ulcer, thrombosed hæmorrhoidal veins, suppurative cholangitis, colitis, acute pancreatitis, furunculosis, typhoid fever, intestinal obstruction, and operations on the gall bladder have been credited as the predisposing factors in some cases. The common causative organisms of primary hepatic abscess are staphylococci, streptococci, pseudomonas aeruginosa (bacillus pyocyaneus), diplococcus pneumoniæ, and others. Often, however, bacteriological studies are misleading because of the frequent occurrence of secondary invading organisms.

The age at which abscess of the liver is most likely to occur is that at which appendicitis is most likely to occur. Males are apparently more susceptible than females.

SYMPTOMS AND SIGNS

According to Keefe, the symptoms vary with the nature and seat of the antecedent disorder, the pathway of infection, and the nature and virulence of the infectious agent. The onset may be insidious, but it is usually abrupt, accompanied by sharp, shooting pain in the right upper quadrant, and associated with a sense of fullness in the epigastrium, or oppression in the lower right portion of the thorax. Additional symptoms are headache, profuse sweating, nausea, anorexia, gradual loss of weight, emaciation, irritability, lassitude, dry cough, and fever of the remittent type. Frequently spontaneous improvement occurs, followed by periods of recurrence of symptoms.

The temperature usually fluctuates between normal and 105 or 106 degrees F. The rapidity of loss of strength and weight may even lead one strongly to suspect malignancy. Tenderness under the right costal margin is frequently present and usually can be elicited by one or more methods. Tenderness in the region of the abscess is said always to be present as a result of direct stretching by the abscess of the liver. However, some difficulties may be encountered in eliciting this most important sign in the usual way. Deep fistic percussion generally succeeds. Ludlow has called attention to a special sign for revealing the usual deep seated pain of hepatic abscess by a sudden thrust with the end of the finger. The usual point at which this sign appears is within the ninth intercostal space, about 5 centimeters from the right costal margin. Pain is an inconstant symptom, but when present it is significant. It may even be vague intra-abdominal or intrathoracic distress. Increased intrahepatic pain on pressure, however, must be distinguished from disease of the gall bladder or kidney, and from ulcer of the stomach or duodenum. Thoracic pain as a result of pressure and displacement is sometimes more easily interpreted. Pain in the right shoulder, when present, is the result of pressure on the endings of the phrenic nerve.

Jaundice may be present from the start, or it may come on very early It usually persists and fluctuates in intensity during the course of the disease. Hepatic dullness is increased, dependent on the situation of the abscess. Enlargement and tenderness in the right upper abdominal quadrant is the usual observation, whereas hepatic abscess on the left side is uncommon. The right side of the diaphragm is very likely to be elevated, to have little, if any, excursion, and to be associated with impaired resonance of the lower part of the right lung. Œdema of the anterolateral aspect of the thoracic walls, extending from the sixth to the eighth interspace, is considered by many as a pathognomonic sign of hepatic disease. However, its appearance is so delayed in the course of the disease that it rarely influences the diagnosis. Enlarged spleen is common but fortunately makes its appearance late. Nevertheless, malaria too frequently has been suspected in these cases.

LABORATORY RESULTS

Anæmia is of the secondary type, and progressive, with marked destruction of blood cells. Regenerative powers of the hæmatopoietic organs apparently cannot keep pace with the increasing anæmia. Leucocytosis is present and may be high. Frequently the leucocyte count is only slightly elevated and remains undisturbed during violent changes in temperature. Roentgenologic studies may give entirely negative results, or they may offer valuable assistance. Fluoroscopic examination frequently reveals elevation of the dome of the diaphragm on the affected side, with restricted movement. Pulmonary reaction of the adjacent lobe may be a confusing observation, and may lead to the diagnosis of basal pneumonia. Following rupture of the abscess beneath the diaphragm, the diagnosis of hepatic abscess may seem unwarranted. Finally, on perforation of the diaphragm, with the admission of pus to the thoracic cavity, the diagnosis of empyema or pleurisy with effusion may seem to be assured without any suspicion as to the presence of the hepatic abscess. Undoubtedly, there are instances in which a ruptured pyogenic abscess of the liver has been treated as empyema, with good results. Perirenal abscess likewise may be impossible to exclude. Artificial pneumoperi-

toneum, used as an adjunct to roentgenologic studies, may be of value in some cases.

PATHOLOGY

Pyogenic abscesses of the liver may be single or multiple. The large, single abscess calls for prompt surgical measures. According to Moynihan, about 70 per cent are single and affect the right lobe. This may be explained by the fact that the right portal branch is the largest, swiftest, and most direct route by which infective emboli can gain access to the portal spaces. The left lobe of the liver is affected in only 15 per cent of cases and, if it is affected, two abscesses are likely to be present within the liver.

Following the implantation and proliferation of bacteria in the portal spaces, the abscess begins as phlebitis, with occlusion of the smaller portal branches, as described by Kaufmann. Necrosis follows rapidly. A surrounding, purulent exudative inflammation accompanies the necrosis, and the involved mass of hepatic tissue is soon liquefied. The single abscess cavity is large, irregular in outline, and circumscribed by a thickened fibrous capsule in the chronic form of the disease. The abscess not infrequently remains sterile. At times the abscess may be partially absorbed and the cavity completely obliterated.

DIAGNOSIS

An accurate diagnosis may be very easily attained if one suspects the presence of hepatic abscess from the start. However, at best, the development of a correct diagnosis is usually a trying affair. The following should be excluded: pyogenic infections elsewhere in the body, malaria, pneumonia, tuberculosis, malignancy, gumma, and hydatid cyst. The diagnosis may be said to be based completely on the history of some recent intra-abdominal surgical procedure; remittent fever; enlarged, tender liver; and fluoroscopic examination.

REPORT OF CASE

A locomotive fireman, single, aged 32 years, was admitted to the clinic October 29, 1930. The family history was essentially negative. The past history included fracture of the right hip, when a horse fell on him, in 1914; influenza in 1918; appendectomy for acute appendicitis, without drainage, in 1925; and hæmorrhoidectomy in 1927.

The patient complained of two distinct types of pain. He gave a history of having had severe pain across the lower sacral region, which extended down the backs of the thighs and into the knees, and which was more or less constant. He had been in bed for 2 weeks, and had received one or more hypodermic injections of morphine daily. The other type of pain he described as stomach trouble, which had been present for the last month. It had begun as severe pain in the epigastrium, which was somewhat intermittent, lasted about 5 or 6 hours, and was not associated with nausea or vomiting. After the first 2 or 3 days, the pain was confined to the lower part of the abdomen, was worse at night, and was aggravated by the presence of food in the stomach.

General examination revealed that the entire abdomen was held rigidly and that the patient had superficial tenderness in the lower part of the abdomen, particularly on the left side. There was nothing to suggest disease of the gastro-intestinal tract. Special reports included the following: hæmoglobin, 13.1 grams in each 100 cubic centimeters of blood (normal, 15 to 17 grams); erythrocytes, 4,320,000 and leucocytes, 7,400 in each cubic millimeter of blood; urine, normal; teeth and tonsils normal; roentgenograms of the stomach and thorax gave no evidence of abnormality; the roentgenologist reported that the gall bladder was functioning normally; a roentgenogram of the kidneys, ureters, and bladder gave evidence of some thickening about the margins of the right sacro-iliac joint, an old fracture of the transverse process of the last lumbar vertebra on the right side, with secondary myositis ossificans in the region of the ileolumbar ligament, and dealignment of the symphysis pubis.

Orthopedic examination disclosed that the spinal column was held straight, and that bending backward and to the right was limited. Pain in the lower part of the abdomen could not be connected with any trouble in the back, and accordingly a search for foci of infection and a neurologic examination were advised.

Neurologic examination revealed that the central nervous system was objectively normal, but because of the possibility of the pain being root pain, spinal puncture was done, and the patient remained overnight in the hospital. The following morning he returned to his rooming house. However, he did not return to the clinic for completion of the examination. Examination of the spinal fluid gave negative results.

The patient was seen in his room, and his condition was diagnosed as postpuncture headache. Eight days after the spinal puncture, the patient was still in bed, and had not returned to the clinic because he was too weak. His temperature was 102.8 degrees F. and his pulse rate 90 beats each minute. He was sent into the hospital that night.

Four days after this second admission to the hospital the patient complained of pain in the entire anterior part of the thorax of 36 hours'

duration and unassociated with gastro-intestinal symptoms. The temperature rose to 103.2 degrees F., leucocytes numbered 14,000 in each cubic millimeter of blood, and the concentration of hæmoglobin was 45 per cent. The patient looked sick and was unco-operative. General examination revealed a stiff neck, and a bilateral positive Kernig sign graded 2. His handgrips were weak. The abdomen was not satisfactorily palpated because of voluntary rigidity. The diagnosis was indeterminate, but the suggestion was made that generalized infectious myositis might be present.

On the third day in hospital the pain disappeared entirely, and the patient felt well except for weakness. Examination revealed jaundice of the sclera and skin, graded 1 to 2. The abdomen was still distended, but the rigidity seemed voluntary. There was dullness to percussion in the right upper quadrant, and questionable firmness. Evidence of definite anæmia had developed since examination in the clinic. The patient was eating well and his bowels were functioning satisfactorily. On the fourth day in the hospital his general condition remained satisfactory, but he was still febrile. Examination revealed tenderness, graded 2, over the right kidney, posteriorly, laterally, and at the middle portion of the abdomen, anteriorly, on the right side. The right side of the diaphragm was definitely elevated. Roentgenologic examination did not disclose abnormality within the thorax. Perinephritic and subdiaphragmatic abscess were considered.

November 19, the patient complained of severe pain at the lower end of the sternum, and there was rigidity, tenderness, and dullness in the right upper quadrant of the abdomen. The question of exploration was imperative. It was not considered wise to explore because of the poor surgical risk and the probability of a malignant process being present.

The following possibilities were considered: empyema of the gall bladder, with low grade abscesses in the liver from staphylococcic infection; an acute inflammatory process in the upper part of the abdomen, either local or part of a generalized infectious or malignant process; a progressive, acute disturbance in the upper part of the abdomen culminating in an acute condition, such as a perforating duodenal ulcer or similar lesion; subdiaphragmatic abscess; perinephritic abscess; and abscess of the liver.

November 22, roentgenograms of the thorax gave evidence of bronchopneumonia involving the base of the right lung. The concentration of sugar in the blood was 150 milligrams in each 100 cubic centimeters. A few days later exploration, under spinal anæsthesia, was advised. Five cubic centimeters of 10 per cent solution of calcium chloride, mixed with 200 cubic centimeters of physiologic solution of sodium chloride, was given intravenously on two successive days before operation. The coagulation time (Boggs) was 8 minutes, 30 seconds, and the bleeding time was 2 minutes, 30 seconds. The urine was normal except for a trace of bile. Repeated examinations of the blood prior to operation disclosed that the concentration of the hæmoglobin averaged about 38 per cent, that erythrocytes numbered 3,000,000 and leucocytes 14,000 in each cubic millimeter of blood. The van den Bergh reaction was direct, and the concentration of serum bilirubin fluctuated between 1.0 and 5.2 milligrams in each 100 cubic centimeters. During the 14 days before operation the temperature fluctuated from 105 degrees F. to normal, and the pulse rate varied from 80 to 130.

November 26, an upper right rectus incision was made. The lower part of the abdomen was found to be normal. Between the liver and the diaphragm from 10 to 15 cubic centimeters of pus was found, which did not seem enough to account for the patient's illness. The hepatic tissue appeared to be in good condition; the edges were feathery; there was no localized swelling or bulging, although the right lobe appeared to be a little fuller than normal. A needle was passed into the right side of the liver for a distance of 7.5 centimeters, and a large pocket of pus was found. A trochar was passed, and about 700 cubic centimeters of greenish yellow, odorless pus was evacuated from the anterior and superior portion of the right lobe of the liver. The index finger was then inserted, but adjacent abscesses were not revealed. A large tube was inserted for drainage, and was stitched to the capsule of the liver. Strips of iodoform gauze were packed around the tube. Further exploration was not done. Culture of material from the abscess cavity, on blood agar and in brain broth, resulted in growths of a green-producing streptococcus. On the first day after operation the wound drained freely around the tube. Irrigations with boric acid were begun the second day, and the boric acid solution was replaced by Dakin's solution on the fourth day. The gauze pack was removed on the tenth day, and the tube was removed on the eleventh day after operation, because the wound was not draining. Each day the patient received intravenous injections of 10 per cent solution of glucose. The temperature remained around 100 to 101 degrees F. until the fourth day after operation, when it rose to 104 degrees F. and continued to be remittent. The pulse rate averaged about 110.

December 11, the temperature began to rise, the pulse rate varied between 120 and 140, and it was thought that a second abscess was developing. However, the original abscess was not draining well. Therefore, 2 days later forceps were inserted to establish additional drainage of the primary abscess, and 250 cubic centimeters of pus was evacuated. However, the pulse rate continued to fluctuate between 120 and 160 and the temperature between 97 and 105 degrees F. Repeated examinations of the blood disclosed that in spite of several transfusions of 500 cubic centimeters or more of blood, the concentration of hæmoglobin remained at 50 per cent. The number of leucocytes remained stationary at 9,000 in each cubic millimeter of blood.

December 15, roentgenologic examination revealed elevation of the diaphragm on the right side, and 12 days later it was elevated to the fourth rib anteriorly. The base of the right lung was infiltrated apparently following consolidation. Twenty-five cubic centimeters of 0.1 per cent mercurochrome was given intravenously in 500 cubic centimeters of physiologic solution of sodium chloride. A second subphrenic abscess was drained January 3, 1931. Four days later toxic psychosis developed, and the patient died January 10, the forty-seventh day after operation.

Postmortem disclosures were as follows: One large and three or four small abscesses in the right lobe of the liver; the large abscess had been well evacuated by drainage; subphrenic abscess; general peritonitis; slight ileus; bilateral hydrothorax (left, 1,000 cubic centimeters; right, 1,500 cubic centimeters) with beginning empyema of the right side; acute diffuse nephritis; ulcerative enteritis; splenomegaly (470 grams; normal 150 grams); healed tuberculous lesions of the lungs and hilar nodes, and arteriosclerosis.

A rather detailed and complete report of this single case of hepatic abscess seems justifiable because of the many interesting features of the case. The diagnosis was obscured from the beginning. The changing symptoms, associated with progressive weakness, anæmia, and loss of weight, aroused the suspicion of the presence of a malignant condition. The history that the patient had undergone operations 3 and 5 years previously seemed to be of little significance. In spite of repeated laboratory examinations and clinical observations, a working diagnosis could not be made, and exploratory operation was delayed. Patients suffering from hepatic abscess, as this patient was, are likely to come to operation in a debilitated state, which adds to the high mortality.

The persistence of chills, fever, and elevated pulse rate following adequate drainage indicated that a second abscess might be present. However, as the patient's condition did not justify further extensive operation, additional exploration was not done. Nevertheless, secondary drainage of small collections of purulent material beneath the diaphragm was effected more than once, apparently with improvement.

A diet high in carbohydrates seemed to be effective in sustaining bodily functions and promoting hepatic regeneration. Repeated transfusion of blood was the necessary factor to allow the patient to go on in spite of the progressive destructive anæmia. Whether or not the second abscess was present at the time of operation, or followed by direct extension, is of no consequence. Nevertheless, postmortem examination gave adequate explanation of the relatively high mortality in cases of primary abscess of the liver; namely, the presence of a second abscess, and the involvement of the pleura and the peritoneum.

PROGNOSIS

It is generally agreed that the mortality resulting from pyogenic abscess of the liver approximates nearly 50 per cent. This does not seem unlikely, for, because of delay in diagnosis, the patients frequently come to operation as poor surgical risks. In addition, the chances of draining adequately more than one abscess cavity are doubtful. Finally, the promptness with which complications of the peritoneal and thoracic cavities follow, makes the operative risk especially great.

TREATMENT

Treatment should aim at free and adequate drainage, the method instituted depending on the size and situation of the abscess.

Although aspiration for diagnosis and treatment has had its adherents, the use of this procedure should be strictly confined to amœbic abscesses. Whenever aspiration is practiced, one should be in a position to explore immediately, should an abscess be present. Repeated aspirations, as a therapeutic measure in cases of hepatic abscess, we feel should be abandoned. Small, well encapsulated, quiescent abscesses are just as likely to become self-limited as they are following aspirations. Negative results of aspiration would hardly influence either the indications for, or site of, an exploratory procedure. Instead, it has been found more satisfactory to use the aspirating needle in the course of the operation. The following methods of operation have become more or less standardized.

Abdominal or transperitoneal method. A right rectus incision is made, and complete exploration of the abdominal cavity is carried out. The liver is then packed off with gauze

pads, and exploratory aspiration, with a good-sized needle, follows. After finding an abscess cavity in the anterior and superior portion of the liver, a large Potain aspirator is inserted. This is followed by placing a large rubber tube through the metal cannula. The tube is then sutured to the capsule of the liver and a generous amount of iodoform gauze is placed around the tube to wall off the draining sinus. In a few days the cavity may be irrigated with solution of boric acid. At a later date, Dakin's solution may be used. The possible disaster from air embolism rules against the use of hydrogen peroxide as a liquefier. If the puncture wound is sufficiently large to admit the index finger, adequate exploration of the cavity should follow. Frequently, partitions of adjoining abscess cavity may be broken down. Should serious hæmorrhage develop, the cavity can be packed. Moynihan's method of suturing the capsule and hepatic substance at the periphery of the abscess cavity to the peritoneal and rectus muscle as a substitute for adhesions which would protect the peritoneal cavity from contamination has not been especially satisfactory.

Transpleural method. This procedure has been found satisfactory at times. The operation can be accomplished in one or two stages, depending on the presence of adhesions. Usually, the diaphragm is sutured to the parietal pleura, and the abscess cavity is opened 1 or 2 days later, either by means of the scalpel or the actual cautery.

Subpleural method. This is the operation of choice. Incision is made along the line of the ninth rib, crossing the anterior axillary line, about 5 centimeters above the costal margin. The rib is resected and the diaphragm is incised. Then the abscess is explored. This method is frequently combined with the abdominal method when the hepatic abscess lies high and posteriorly.

Retroperitoneal method. This operation is rarely used, and seldom indicated.

SUMMARY AND CONCLUSIONS

The occurrence of idiopathic primary hepatic abscess is relatively rare. The etiology usually is obscure. Diagnosis of primary hepatic abscess is seldom made. It should be based on a recent history of some intra-abdominal surgical procedure, remittent fever, the presence of an enlarged, tender liver, and positive fluoroscopic evidence. Treatment should aim at free drainage, the method instituted depending on the size and situation of the abscess cavity. The physical signs, symptoms, and pathological changes are briefly summarized in this paper. A report of one case is included.

BIBLIOGRAPHY

1. ELIASON, E. L. Pylephlebitis and liver abscess following appendicitis. Surg., Gynec. & Obst., 1920, xlii, 510–522.
2. KAUFMANN, EDWARD. Pathology. Philadelphia: P. Blakiston's Son & Co., 1929, ii, 913–922.
3. KEEFE, J. W. Abscess of the liver. Tr. Am. Ass. Obst., 1919, xxxii, 324–332.
4. LUDLOW, A. I. Liver abscess; report of one hundred operations. Surg., Gynec. & Obst., 1923, xxxvi, 336–343.
5. MOYNIHAN, BERKELEY. Abdominal Operations. Philadelphia: W. B. Saunders Company, 1926, pp. 262–272.

CLINICAL SURGERY

FROM THE JAMES BUCHANAN BRADY UROLOGICAL INSTITUTE

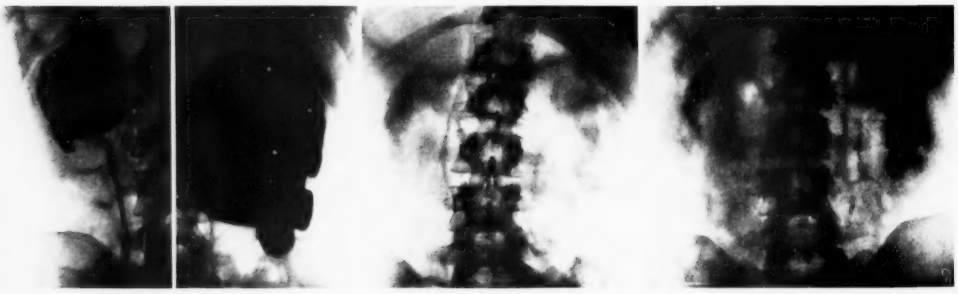
OBSTRUCTIONS TO THE URETER PRODUCED BY ABERRANT BLOOD VESSELS

A Plastic Repair Without Ligation of Vessels or Transplantation of Ureters

HUGH HAMPTON YOUNG, M.D., F.A.C.S., Baltimore

MUCH attention has been directed in recent years to the study of obstructions to the ureter at or near the ureteropelvic juncture, produced by blood vessels or fibrous cords containing blood vessels, generally aberrant in character, which cross the ureter in passing from the great blood vessels to the lower pole of the kidney. While there is still no definite agreement as to the inception of these cases, the consensus of opinion is that operative relief of some sort is necessary in order to prevent a further development of the hydronephrotic condition with ultimate destruction of the kidney. Although in some cases the dilatation of the pelvis and calyces may progress slowly, and after several years not reach very great size, in many other cases the progress of the hydronephrosis is much more rapid and leads quickly to the formation of huge sacs with great thinning of the renal cortex and destruction of the renal function. With the onset of infection, serious pathological conditions with grave general import occur. The history of these cases as a rule elicits indefinite symptoms of pain, dull, aching in character, in one or both kidney regions, with the ultimate development of systemic symptoms as the disease progresses. In some cases, the symptoms may remain slight, although the hydronephrotic condition may be great. The condition may be suspected when, in young patients, without evidence of injury or pathological conditions of the urine, pain comes on insidiously in the renal region. In one of our recent cases, the symptoms were so slight that attention was hardly directed at all to the kidney, but an experimental iopax urogram revealed a considerable dilatation of pelvis and calyces. In the detection of this condition intravenous urography is of great value, but in order to detect roentgenologically the obstruction and kink of the ureter due to a vascular cord, retrograde urography is essential.

After the discovery of unilateral or bilateral hydronephrosis, either producing symptoms or not, one must consider the importance of investigation and relief in order to avoid ultimate destruction of the kidney substance or serious complications due to secondary infection. When both kidneys are hydronephrotic, decision must be made as to which should be attacked first, as will



1. 2. 3. 4.

Fig. 1. Roentgenograms Case 1.

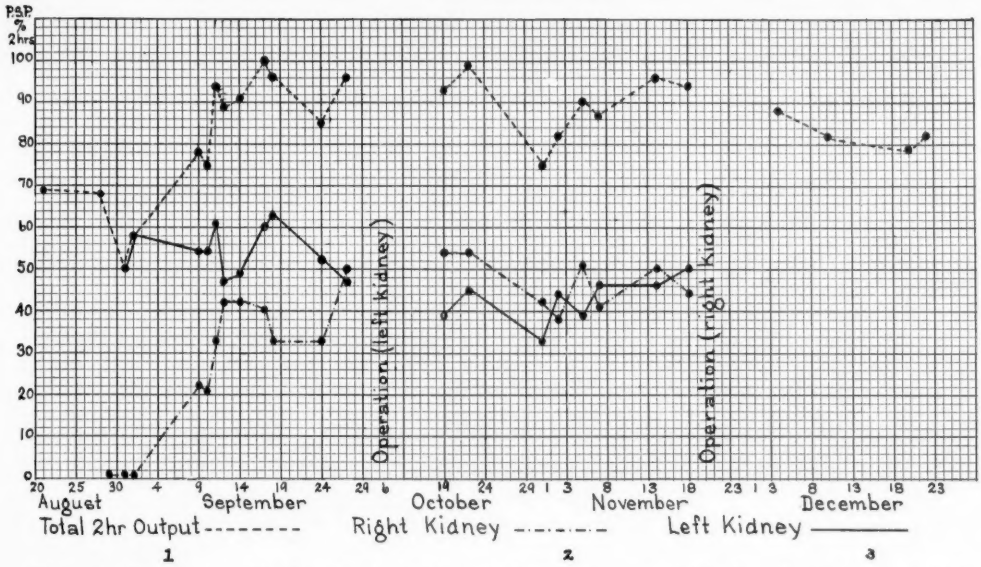


Fig. 2. B. U. I. 19,005. Showing the changes in renal function as a result (1) of continuous ureteral catheter drainage of the right kidney during August and September; (2) during the period after operation upon the left kidney, October, November; (3) after plastic operation upon right kidney (December).

be shown in the first case reported here. Having decided that intervention is necessary for the hydronephrotic condition, it is important at operation that one should proceed cautiously, so as to obtain a complete study of the conditions present at the ureteropelvic juncture, in order that accurate information as to the cause of the hydronephrosis may be determined. By proceeding carefully and demonstrating that the dilatation of the pelvis and calyces is due to aberrant vessels or vascular bands which cross the ureter at or near the pelvic juncture, thus producing compression, kinking, stricture or valve-like conditions which are responsible for the obstruction to free outflow of urine from the pelvis, the operator must determine what means should be adopted to relieve the condition.

During the past 15 years, numerous papers have appeared advising the removal of the obstruction to the ureter by division and ligature of the blood vessels. More recently, however, it has been pointed out that such destruction of vascular supply of the lower pole of the kidney often leads to definite impairment of the organ, and sometimes to pronounced atrophy or even necrosis. On this account Quinby and others have advised that instead of division and ligature of the vessels, the ureter should be cut off and transplanted to another portion of the kidney where good drainage and freedom from vascular compression in the future may be obtained. Such a procedure has apparently not always been successful, and cases in which nephrectomy became necessary are recorded in the literature. Whereas simple removal of the vascular obstruction or transplantation of the ureter was for a time considered sufficient in most cases, the recent trend has been toward resection of the markedly redundant renal pelvis in order to remove permanently the hydronephrotic sac after the obstruction has been removed. But the impairment or serious injury to the kidney produced by ligating the vessels to the lower pole, and the occasionally very imperfect results obtained by ureteral transplantation have brought forcibly to my attention the fact that both these procedures are far from ideal. For some time I have been considering whether it would not be possible by a plastic procedure, while carrying out resection of the dilated pelvis, to separate the vessels and ureter so that the obstruction would be removed, and all chance of future recurrence eliminated. I am glad to report herewith two cases in which it has been shown conclusively that such is possible. As will be described in detail further on, no difficulty was experienced in carrying out resection of the anterior and posterior aspects of the redundant pelvis, and in so closing by sutures the defect thus produced that the vessels and ureter

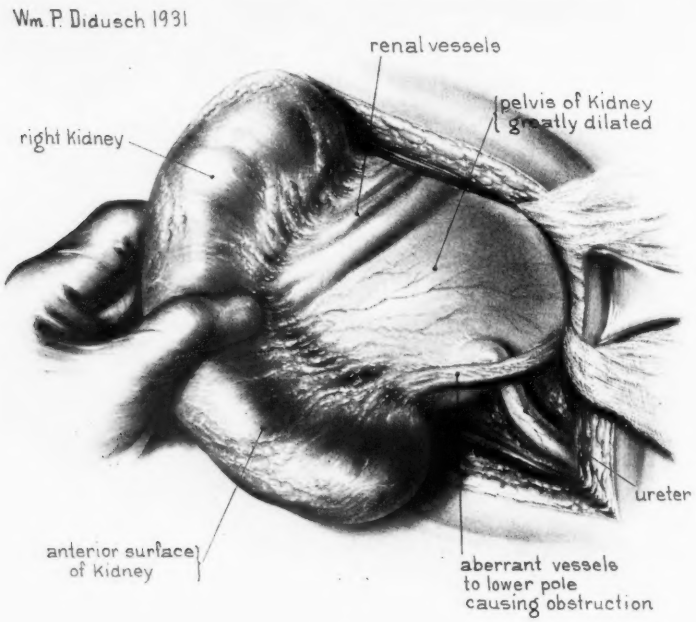


Fig. 3.

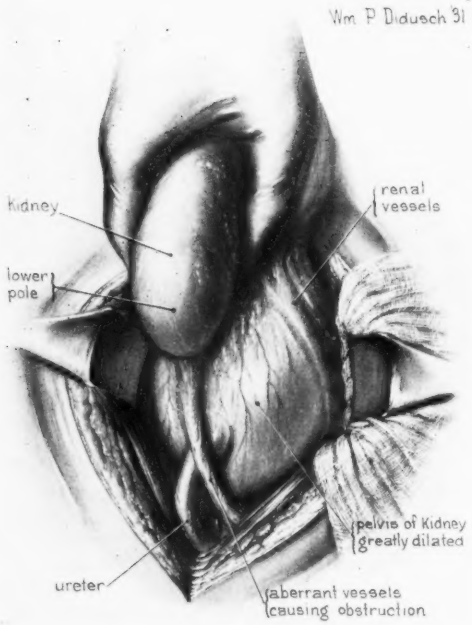


Fig. 4.

Fig. 3. Anterior surface of right kidney which has been delivered through the wound, showing aberrant vessels at lower pole, which caused pressure, kinking, and obstruction to the ureter just below the junction with the pelvis, which has been greatly dilated.

Fig. 4. View obtained by drawing the kidney forward showing the lower portion of pelvis with aberrant vessels obstructing ureter.

were drawn apart and fixed in such a position that it would be impossible for the ureter again to be obstructed by the vessels.

Case I has many points of interest. It was a bilateral hydronephrosis due to aberrant vessels passing over the ureter to the lower pole of the kidney and producing kinking and obstruction on both sides. On the right side the condition had progressed to such an extent that a huge hydronephrotic sac was produced, and the kidney function was so completely impaired that not even a trace of phthalein was found in 2 hours in the catheterized specimen after the pelvis had been evacuated and washed out. Owing to the huge size of the sac, which at one time contained 4,000 cubic centimeters, it was thought advisable to institute continuous ureteral catheter drainage. For a period of over a month, no difficulty was experienced by the patient in voiding urine while the ureteral catheter emerged from the urethra. It

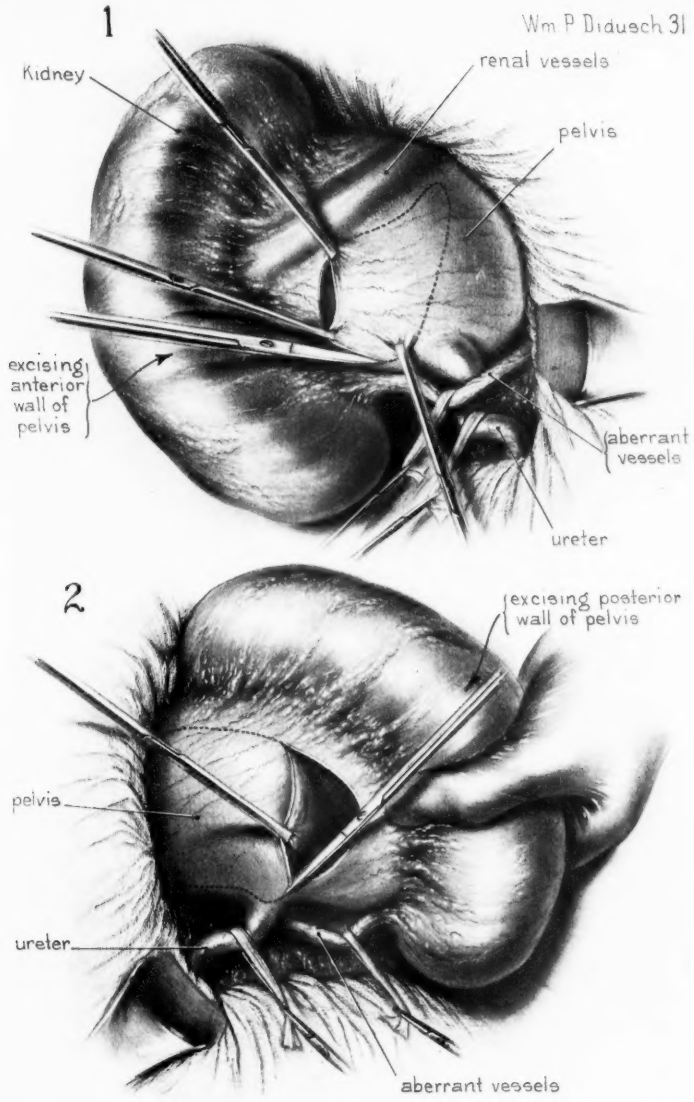


Fig. 5. The new plastic operation to reduce size of pelvis and also to separate ureter and veins from each other. 1, Resection of portion of anterior surface of pelvis; 2, resection of portion of posterior surface of pelvis.

was necessary to change the catheter by cystoscopy at periods varying from a few days to a week or more, depending on the accumulation of pus, and the blocking of the catheter which could be relieved by irrigation and suction. Satisfactory drainage was maintained for several weeks and with remarkable results. At the end of a week a small amount of phthalein was obtained from the supposedly completely destroyed right kidney. At the end of 18 days 22 per cent was eliminated in 2

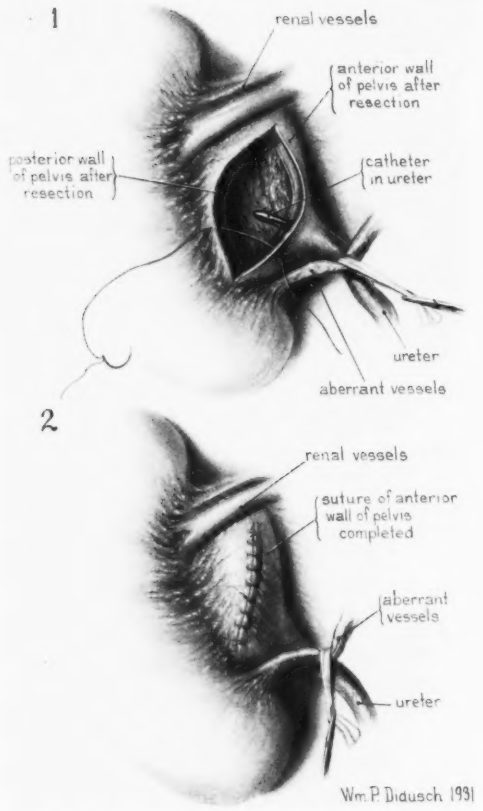


Fig. 6. Sutures employed to close the pelvic wound as shown. In this way the vessels are drawn upward away from the ureter on the anterior surface of the pelvis.

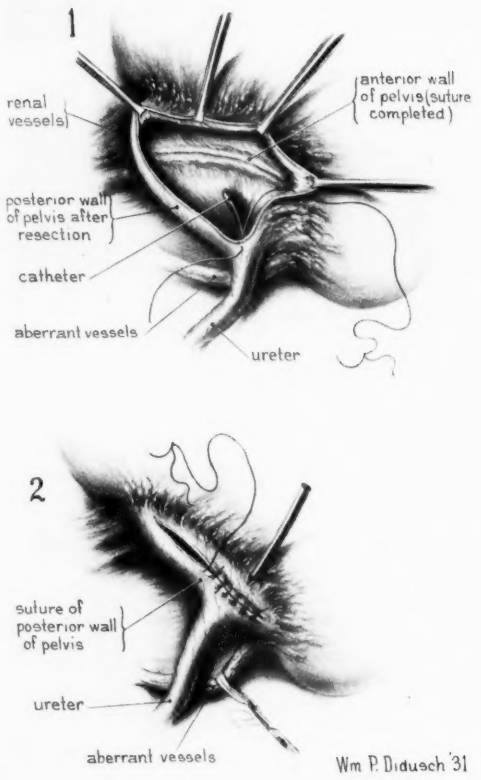


Fig. 7. 1, Closure of the wound after resection of the posterior portion of the pelvis. Sutures are placed so as to draw the ureter backward and upward away from the veins; 2, completion of closure, drainage of pelvis and ureter through stab wound in pelvis near kidney. Note wide separation of veins and ureter obtained.

hours, and at the end of a month the function from this side was 48 per cent, almost as good as the other kidney which had previously been doing all the work. The demonstration of the great value of an inlying ureteral catheter with drainage continuing for many weeks was apparently new, as was the demonstration that such a kidney after years of obstruction and formation of a huge hydronephrotic sac could be restored almost to normal function. As a result of these discoveries, it was decided that this kidney should be preserved and nephrectomy avoided. It was thought advisable to operate at first upon the least damaged side, and when this kidney was exposed, it was clearly shown that the obstruction was due to a fibrous cord containing artery and vein which ran from the great vessels to the lower pole of the kidney, but as compression of these vessels seemed to produce very little change in the vascularity of the lower pole, the operator decided simply to clamp, divide, and ligate the vessels. This completely removed the obstruction and the kinking of the ureter, and inspection of the interior of the pelvis showed that free drainage was thus obtained. During the convalescence following this operation, the divided phthalein tests showed definite reduction in function in the kidney as a result of the ligation of the vessels going to the lower pole; in fact, for a time the function from the opposite side, in which a great hydronephrotic sac was present, and which had originally shown no function, was greater than that of the other kidney

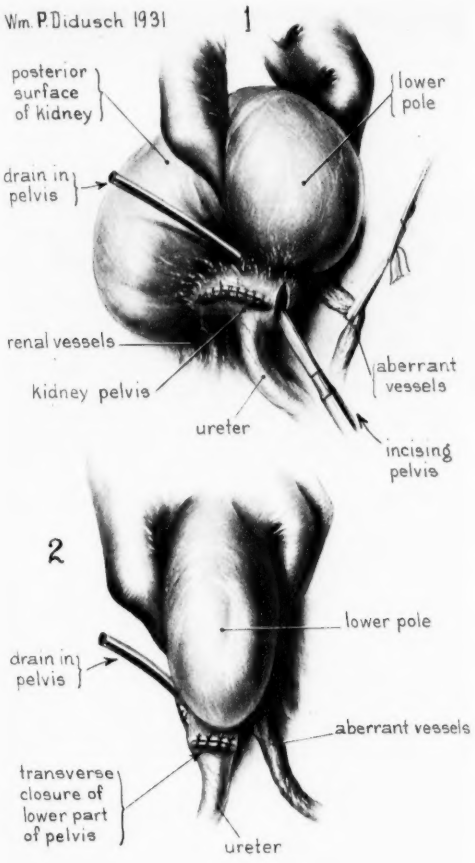


Fig. 8. Additional incision closed by Heinecke-Mikulicz principle employed to bring orifice of ureter nearer lower pole and farther away from veins. Catheter draining pelvis and ureter which was brought out through the skin wound shown.

which on admission was doing all the work. This finding fortified me in my decision to attempt a plastic upon the other renal pelvis by means of which the ureter might be separated from the veins without operating on either. As remarked above, this was carried out in this case, and then in another with apparently perfect success, as will be shown in the details of the 2 cases which now follow.

CASE 1. Bilateral hydronephrosis due to obstruction at the ureteropelvic juncture by aberrant vessels running to lower pole of kidney. Moderate hydronephrosis, left side, with no renal impairment and no infection. Huge hydronephrotic sac, right side, with severe infection, and apparently complete impairment of kidney function. Remarkable recovery of function by continuous drainage for a month with inlying ureteral catheter. Operations on both sides; vessels obstructing ureter ligated and divided on the left side with subsequent impairment of renal function. A new plastic procedure devised and carried out on right side by means of which we succeeded in avoiding operation upon either vessels or ureter, and succeeded in widely separating the two. Complete relief of hydronephrotic sac on both sides as shown by subsequent urograms.

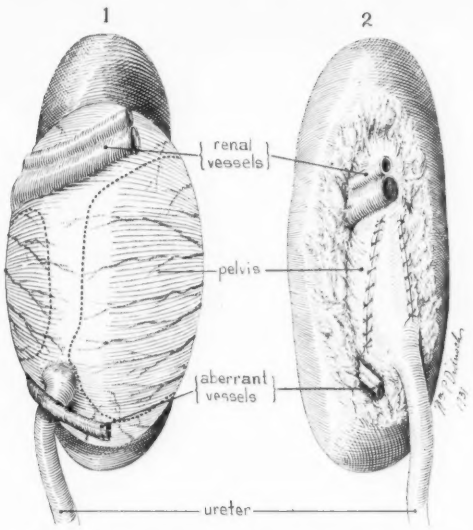
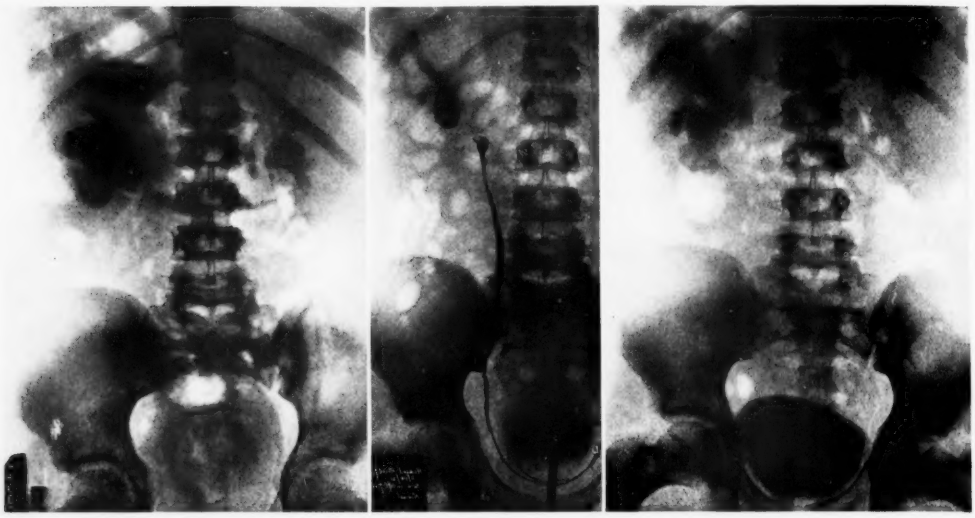


Fig. 9. Drawing to indicate extent of resection. Closure of wounds and separation of ureter from veins.

I. A. G., B. U. I. 19905, male, aged 19 years, was admitted to the Brady Urological Institute August 19, 1930, complaining of "cystic kidneys." The family history was negative. The patient had, in childhood, measles, varicella, pertussis, mumps, dengue fever, tonsillitis, adenoids, and at the age of 17 (2 years ago) scarlet fever. Tonsillectomy was done in 1910. He was frequently constipated, and occasionally had clay-colored stools; was never jaundiced. There was no venereal history. General health had never been good; had always been considered weak, puny, and underweight. In May, 1928, patient had an attack of scarlet fever, after which urine contained albumin, which became greatly decreased while the patient was in the reclining posture. A diagnosis of orthostatic albuminuria was made. In July, 1929, there was considerable swelling beneath the ribs in the right half of the abdomen. This was associated with a sense of pressure, but there was no pain, nausea or vomiting, or other genito-urinary or gastrointestinal symptoms. There were no chills or fever. Heat was applied and after a few days the swelling disappeared. An X-ray was obtained, and a tentative diagnosis of enlarged gall bladder was made. After this the swelling recurred about every 6 weeks, lasting each time several days, but unassociated with any local or constitutional symptoms.

In April, 1930, the patient's physician decided that a laparotomy should be carried out on account of the supposed greatly distended gall bladder. An incision was made



1. 2. 3.

Fig. 10. Roentgenograms, Case 2.

in the right side of the abdomen. The gall bladder was found to be normal, but a very large "cyst of the right kidney" was found, and drained through a puncture in the right side, extraperitoneally. Over a gallon of fluid was evacuated. The left kidney was palpated through the abdominal incision, and found also to be enlarged, but not nearly so great as the right. A rubber tube was inserted through the punctured wound into the pelvis of the right kidney, and drainage was instituted for several weeks. It was reported that at first the functional tests showed no output of phthalein from the right kidney, but after 2 months there was a pronounced increase in the phthalein output, which was said to have risen as high as 30 per cent in 2 hours from this kidney. It was stated that the kidney became infected from the operation, but after 2 months the urine cleared up. A pyelogram was taken of the left kidney, and considerable hydronephrosis was discovered. On this account, it was deemed inadvisable to carry out nephrectomy on the right side. The drainage tube was then removed from the right side and the wound healed promptly. After that the patient had a recurrence of the swelling in the region of the right kidney, associated with pain and a sense of marked pressure. His physician then carried out once a week ureteral catheterization and pelvic lavage. There was no history of pain in the left kidney, or of hæmaturia, lithiasis, or difficulties of micturition. The patient was much underweight and in poor health.

Examination. The patient was pale and undernourished. Lungs and heart were negative. The abdomen showed a long scar through the upper right rectus (exploration of abdomen). There was also a small scar in the right costovertebral angle, through which the right kidney had been drained. The scar was well healed; no hernia. The right kidney was enlarged, palpable to the level of the umbilicus, and very slightly tender. The lower pole of the left kidney was palpable, but apparently there was no marked enlargement. The genitalia were negative. Rectal examination revealed the prostate, negative; the seminal vesicles, slightly indurated and adherent.

Urinalysis, August 21, showed the urine to be cloudy, alkaline; specific gravity, 1010; no albumin; no sugar; no casts; white blood cells, rare; red blood cells, none; cocci, 3+. Phthalein test showed: August 21, appearance time 8 minutes, half-hour readings, 10, 12, 25, and 22 per cent. Total within 2 hours after injection was 69 per cent. The blood urea was 0.28 milligrams per 100 cubic centimeters. The blood pressure was 112–74. Plain X-ray films showed the right kidney much enlarged, no evidence of calculi.

Cystoscopic examination revealed no stricture, no residual urine; bladder capacity, 400 cubic centimeters. The prostatic orifice was normal. There was no trabeculation of the bladder, or hypertrophy of the trigone. The ureteral orifices were apparently negative. A Garceau catheter was easily passed up the right ureter to the pelvis of the kidney, and 1,000 cubic centimeters of fluid was obtained in 45 minutes. Comparative phthalein tests were attempted, but were not successful. A stereoscopic right pyelogram was obtained after injecting 500 cubic centimeters of sodium iodide, and showed a huge hydronephrosis apparently due to stricture at the ureteropelvic juncture.

Following cystoscopy the patient had a reaction characterized by considerable increase in pulse rate and a rise in temperature to 101.6 degrees. On the following day the temperature and pulse slowly declined and returned to normal in about 9 days.

On August 28, second phthalein test revealed the appearance time, 8 minutes; half hour readings, 22, 24, 12 and 10 per cent; total in 2 hours, 68 per cent.

August 29, a second cystoscopy was done; both ureters were catheterized. Phthalein test showed the urine from right side to be cloudy and to contain pus cells; culture, showed bacillus b proteus; the urine from the left side, no pus cells; culture sterile. The appearance time from right side was 10 minutes, and a mere trace of phthalein remaining at the end of 30 minutes. The amount of urine removed was 50 cubic centimeters. On the left side, the appearance time was 7 minutes, eleven per cent was excreted the first 15 minutes, 21 per cent the second 15 minutes, a

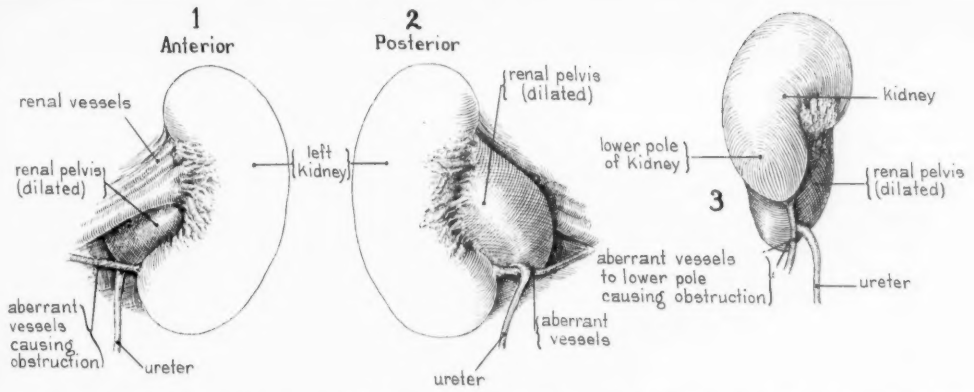


Fig. 11. Anterior and posterior surface of kidney and lower pole in Case No. 2, showing aberrant vessels to lower pole and the resultant kinking and obstruction of the ureter.

total of 32 per cent being excreted for ½ hour. The amount of urine obtained from left side in ½ hour was 30 cubic centimeters. No phthalein was obtained transvesically. The capacity of the hydronephrosis on the right side was 1,000 cubic centimeters; on the left side, 150 cubic centimeters. The left pyelogram revealed hydronephrosis of the kidney pelvis, only about one-third size of the right.

Bilateral retrograde pyelograms were done with 12½ percent sodium iodide. As seen in Figure 1, *1* and *2*, both kidneys were markedly hydronephrotic. The left kidney pelvis was the smaller of the two, was somewhat pear-shaped, and measured 3½ by 3 inches. The most interesting feature was marked kinking and obstruction in the ureter just at the ureteropelvic juncture. The ureter was seen here to be compressed (no shadowgraphic fluid was shown at this point), was directed outward and pronouncedly kinked as it entered the pelvis. (At operation it was shown that this was produced by a fibrous band containing artery and vein, which ran from the great vessels to the lower pole of the kidney, thus producing compression and kinking of the ureter.) The kidney cortex was somewhat thin.

On the right side the pelvis was greatly dilated, measuring 6½ by 4½ inches. The ureteral catheter was seen to pass upward over the front of this dilated pelvis. The ureteropelvic juncture was not seen. The kidney cortex was greatly thinned.

Following this cystoscopy the left ureteral catheter was removed. A catheter was left in the right ureter continuously, to drain the huge hydronephrosis. After the patient was returned to the ward, a purulent, greenish fluid continuously flowed from the pelvis. There was so much thick pus present that the catheter frequently became plugged and required aspiration.

August 31, differential phthalein. The urine from the left side was obtained transvesically. No phthalein was obtained in 2 hours from the right side. On the left side, the appearance time was 7 minutes, and half-hour readings showed 15, 15, 10, and 10 per cent, a total of 50 per cent being obtained in 2 hours. The ureteral catheter was left to drain the right kidney. The drainage from the right kidney was occasionally unsatisfactory because of the thick mucopus.

September 5, the right ureteral catheter, which had been in place 7 days, was removed. Cystoscopy was carried out. A Garceau catheter, which was inserted to the kidney, showed that the pelvis was practically empty, thus indicating satisfactory drainage. With the Garceau catheter inserted only 8 centimeters into the left ureter, 125 cubic centimeters of 12½ per cent sodium iodide was introduced, and a pyelogram obtained. This showed the same picture as in the previous film, except that the ureter was filled. This examination was also made with patient in upright position, and no ptosis was revealed.

The right Garceau catheter was replaced by a No. 7 catheter introduced up to the kidney pelvis, and left in place for drainage. Four days later, the drainage having been very satisfactory, a phthalein test showed for the first time the presence of phthalein coming through the catheter draining the right kidney. The fluid excreted in 2 hours from the right side amounted to 710 cubic centimeters, from the left side, 550 cubic centimeters.

On September 9, the right kidney had been more or less continuously drained by an inlying ureteral catheter for 19 days, and during this time a remarkable transformation in the renal function of the right kidney had occurred, as previously stated. The phthalein, which had previously been only a trace, improved wonderfully and had reached 22 per cent in 2 hours from this kidney, which on admission 2 weeks before had 1,000 cubic centimeters fluid removed from it and at operation several months previously, 4,000 cubic centimeters were said to have been removed. An interesting chart prepared by Dr. S. A. Vest (Fig. 2), shows the amazingly rapid improvement which occurred in the right kidney, which had been drained continuously with the catheter. As seen here, during the next 5 days, the phthalein obtained from the right kidney rapidly mounted from 22 to 42 per cent in 2 hours. At the same time the appearance time dropped from 12 minutes to 7 minutes, and the amount excreted during the first half-hour increased from 10 to 20 per cent. During the next 2 weeks the improvement of phthalein on the right side was maintained, the reading on September 27 being 50 per cent in 2 hours, whereas on the left side the phthalein remained constant between 52 and 63 per cent. During the first 6 weeks after entrance, the condition of the patient remained about the same. He ran at times a temperature which twice reached 102 degrees, and pulse of 120. These occurrences generally coincided with the plugging of the ureteral catheter, and were accompanied by some pain and symptoms of

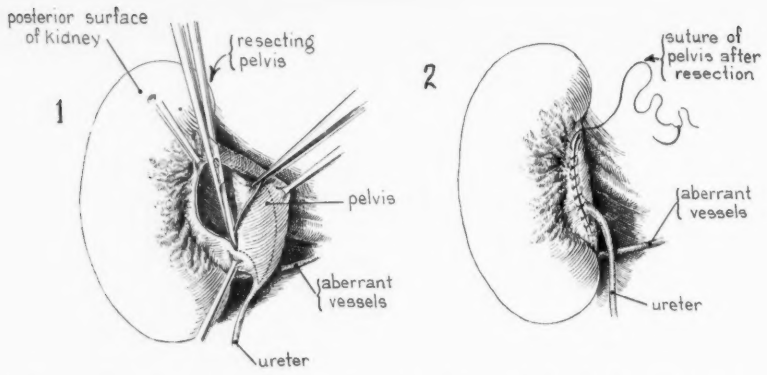


Fig. 12. Young's plastic operation to move ureter from proximity of veins. The resection carried out on the posterior surface of the pelvis is shown and appearance after closure by suture.

distention, and pain in the region of the right kidney which had been much improved by continuous ureteral catheterization. As the function of the right side was now almost as good as that of the left side, and as there was no infection present on the left side, it was deemed advisable to operate, first upon the left kidney.

Operation. October 6, operation was performed by Young and Frontz. Ethylene anæsthesia was used; extraperitoneal exposure of left kidney pelvis and ureter. Discovery of aberrant vessels running to lower pole, which crossed ureter just below entrance to pelvis, producing acute flexure and definite obstruction with dilatation of left kidney pelvis about 5 centimeters in diameter above it. Ligation and division of aberrant vessels followed by complete removal of kink in ureter, and evacuation of dilated pelvis. The kidney was exposed through a curved incision; the abdominal muscles were divided. The kidney itself was a little larger than normal, suggesting a definite hypertrophy; it was firm and seemed to be in good condition. As the kidney was exposed, a large extrarenal hydronephrosis came into view, and investigation revealed a band of vessels which ran from the great vessels to the lower pole of the kidney and thus crossed, compressed, and kinked the ureter just below the ureteropelvic juncture, the relationship being such that definite obstruction was produced. The pressure occasioned by these vessels upon the ureter and their surrounding tissues gave the upper ureter a sigmoid-like course. The operator was at first uncertain whether to divide the vessels or to preserve them and reimplant the ureter to another part of the pelvis.

Palpation of the group of vessels revealed a definite pulsation, but when compressed by a rubber-shod clamp, no pronounced circulatory change in the lower pole of the kidney was seen. It was therefore decided to sacrifice them instead of transplanting the ureter. They were clamped, divided, and ligated with No. 1 chromic catgut. Following this the upper ureter immediately straightened out, and palpation of the ureteropelvic juncture revealed no definite thickening. It was decided, however, to open the pelvis just above the ureteropelvic juncture. An incision 1 centimeter long was made. The ureteropelvic juncture was inspected through this opening. It seemed normal. A large bougie was passed down into the ureter for 18 to 20 centimeters without encountering an obstruction. It seemed evident that there was no stricture, valve, or abnormal insertion, and that drainage would probably be good. The pelvic wound was then closed by two plain ligatures which did not go through the mucous membrane. The kidney was put in its normal place. Inspection of the ureter showed no kinking. The wound was then closed by Dr. Frontz, with a small rubber drainage at the upper angle, the fascia and muscles being approximated with figure of eight chromic catgut. Silk was used for the skin with 4 through-and-through silver wire tension sutures. Condition of patient was excellent. Duration of operation was 1 hour and 5 minutes. Following operation drainage of the right renal pelvis was maintained by an inlying ureteral catheter.

Postoperative course. The patient returned to the ward in good condition. He took fluids well. The retained ureteral catheter on right side was aspirated and attached to Connell bottle. The condition at close of day was excellent. On day following the operation the temperature rose to 102 degrees and the patient began vomiting. Murphy drip was instituted with salt solution and subsequently glucose was employed. Later the ureteral catheter draining the right kidney became plugged, could not be aspirated, and was removed. During the next 3 days the patient continued to have a pulse of 120, and this was accompanied by temperatures which varied between 102 and 103 degrees. Under infusions and rectal drip, the nausea gradually diminished. On the fourth day following operation the blood urea suddenly rose to 112 milligrams per 100 cubic centimeters and patient was given 500 cubic centimeters of 5 per cent glucose intravenously. The same amount in glucose was given 16 hours later, and again 8 hours later. On the following day two additional intravenous injections of glucose, 5 per cent, 600 and 500 cubic centimeters, were given, and again on the following day 600 and 700 cubic centimeters were administered. The patient thus received, within 3 days, 3,900 cubic centimeters of 5 per cent glucose intravenously. These injections were accompanied by steady diminution in pulse to 90 and temperature to 100 degrees. During these 3 days the blood urea fell, and, on the ninth day following the last injection, the blood urea had dropped from 112 to 32 milligrams per kilogram. On the tenth day after operation, the patient's condition had improved so much that it was thought possible to carry out cystoscopy, and reinsert the catheter for continuous drainage of the right kidney, through which mercurochrome was injected into the right renal pelvis.

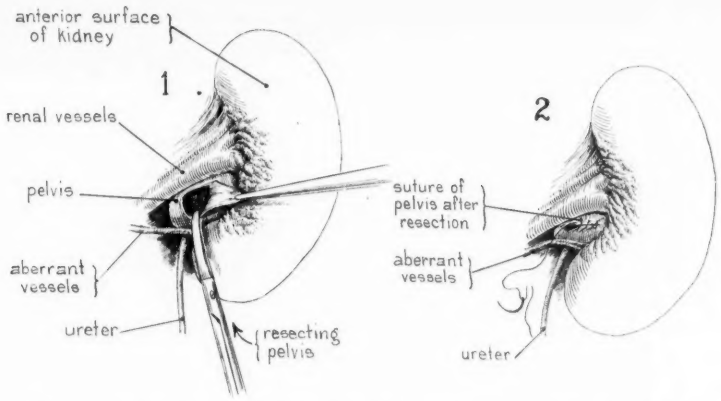


Fig. 13. Anterior surface of kidney showing resection as carried out, and suture transversely to draw vessels upward and away from the proximity of the ureter. In this way the ureter and veins were widely separated from each other and all chance of obstruction in the future is removed.

On October 19 (13 days after operation) phthalein estimations were made. From the right side the 2 hour total was 54 per cent, but from the left side (operated upon, veins to the lower pole ligated), only 30 per cent was obtained, as shown in the chart prepared by Vest (Fig. 2). As shown here the left kidney, impaired by operation, gradually improved in function, and the right kidney maintained its previously good function, often equalling that of the left side. During this entire period of 1 month, ureteral catheterization of the right renal pelvis was maintained, the catheter being changed only once during these 4 weeks. During this time the temperature remained normal, the pulse averaged 90, and the condition of the patient was excellent. The blood urea varied from 24 to 32. At this time the patient was considered sufficiently improved for operation upon the huge hydronephrosis on the right side. On November 13, another right pyelogram was done, with 500 cubic centimeters of fluid, 12½ per cent sodium iodide, and showed a huge hydronephrosis due, apparently, to a stricture at the ureteropelvic juncture.

Operation was done November 19, 1930, by Young, under gas anæsthesia. Extraperitoneal exposure of the right kidney pelvis, and ureter. Discovery of huge hydronephrosis; aberrant vessels to lower pole, causing kink in ureter just below ureteropelvic juncture. Kidney greatly thinned and enlarged, lobulated. Resection of large part of anterior wall of pelvis with plastic to draw blood vessels compressing ureter upward and forward. Similar resection of posterior wall of pelvis with plastic to draw ureter upward and backward away from veins. Completely successful. Ureter and pelvis drained through small stab wound in posterior surface of pelvis brought out to upper angle of skin wound. Kidney replaced in proper position. Wounds closed with catgut and silk. Condition of patient excellent.

The kidney was exposed through a long curved incision back of the previous operative scar. It was easily reached and found to have pronounced adhesions along lower border and over lower portion of the pelvis. The kidney was much longer than usual, but its renal substance felt firm and fairly good, the cortex not being markedly thin. The pelvis was very greatly dilated in the form of a huge sac, with the ureter kinked by a large cord of blood vessels which ran to the lower pole, as is graphically shown in Figure 3, made at the time of operation. As seen here, the ureter was definitely enlarged and thickened. It passed up along the anterior surface of a greatly dilated pelvis, which hung far below but extended well over toward the midline, smaller than shown in the pyelogram (the result of prolonged drainage). As seen in Figure 4, an artery and vein forming part of a fibrous cord, ran from the great vessels across the lower anterior part of the pelvis across the front of the ureter to the lower pole of the kidney. The ureter was compressed and kinked by the vascular cord. The ureter was dilated somewhat above the constricting vessels, and was thickened below the point of compression by the vessels. The ureter was freed for a distance of 4 to 5 inches, and no adhesions or anything suggesting stricture were found. An incision was made in the anterior surface of the pelvis in order to allow a view of the ureteral orifice. It was found to be ring-like, fairly thick and apparently muscular. A good view was obtained, and apparently no stricture or valve was present, as it was possible to pass a fairly large clamp into the ureter by the side of the ureteral catheter which he had been and was still wearing. The interior of the pelvis was rough, strawberry-like, and thick pus was present. The operator then considered a plan which he had previously thought of, of carrying out resection and a plastic in front and behind, with the idea of carrying the ureter backward and upward, and the veins forward and upward so as to separate the two as widely as possible, and prevent further compression of the ureter by the veins. If this could be successfully carried out, it would do away with the necessity of dividing and ligating the veins or of dividing and transplanting the ureter, and at the same time the pelvis would be reduced to proper size. After careful investigation it was found possible to carry this out without difficulty. The operation is shown very graphically in the drawings by Mr. Didusch made at the time. As seen here, a somewhat elliptical area of the anterior wall of the dilated pelvis was excised (Fig. 5, *1*). A larger area of the posterior wall of the dilated pelvis was then excised (Fig. 5, *2*). The pelvis was then closed anteriorly with chromic catgut so as to draw that portion of the pelvis to which the vascular cord was adherent upward and inward (see Fig. 6). The

posterior wall of the pelvis was then sutured in a similar manner so as to draw the ureter upward and backward (Fig. 7). The Heinecke-Mikulicz principle was also used here, chromic catgut No. 2 again being employed. Before closure a fairly large ureteral catheter was inserted through a stab wound in the pelvis into the ureter. Several holes were made into it so that the pelvis might drain both externally or down the ureter. The ureter was fastened by suture to the pelvis and brought out through the skin wound. Investigation showed that an additional small incision with Heinecke-Mikulicz closure would draw the orifice of the ureter further downward and reduce the pouch at the lower end. This was accordingly carried out, as shown in Figure 8. As a result of this plastic operation the pelvis was reduced to almost normal size and the vascular cord and ureter were drawn forward and backward respectively until they were certainly at least 2 centimeters distant from each other (Fig. 9). When the kidney was put into normal position, there appeared to be no possibility of the ureter again being obstructed by this vascular cord. Careful hæmostasis had been preserved throughout the operation by either ligating the vessels with plain catgut, or touching unimportant points of hæmorrhage with the high frequency current. Very little blood was lost, the patient was not shocked, and the condition at the end was good. The muscles and fascia were approximated with two continuous layers of heavy chromic catgut, reinforced by three mattress sutures of silver wire and silk for the skin. Drainage at the upper angle was established with a rubber tube, in addition to the ureteral catheter which drained the pelvis and ureter.

Postoperative course. The patient did very well on the day following the operation, but on the next day the temperature rose to 101.6 degrees and on the following day to 101.6 degrees, and pulse to 140. Blood culture was reported positive for bacillus coli (heavy growth). At 8 p.m. on the second day after operation, the patient was given mercurochrome, 1 per cent, 12 cubic centimeters intravenously. Cultures were taken that day, and again on the next day they were reported negative, and thereafter the blood remained sterile, and the temperature slowly dropped to normal 6 days after the mercurochrome injection. No definite statement can be made as to the efficacy of the intravenous therapy. As a precautionary measure, a continuous infusion of salt solution was started immediately after the patient returned to the ward. On the following day, owing to nausea and vomiting and abdominal distention, very little fluid was taken by mouth, but the infusion into the thigh was continued. On the day of operation the total fluids thus received was 2,400 cubic centimeters, on the next day 6,195 cubic centimeters, on the third, 7,525 cubic centimeters, and on the fifth day, 5,200 cubic centimeters. On the sixth day the infusion needle was removed as the patient was then able to take water in considerable amount by mouth. On this day the patient received 5,400 cubic centimeters by mouth. After this the patient rapidly improved and the temperature became normal on the ninth day and remained so thereafter. On the third day after operation mercurochrome, 1 per cent, was injected through the ureteral catheter in the right lateral abdominal wound and was found in the urine voided. This catheter, leading to the right pelvis, drained urine more or less satisfactorily until removed on the seventeenth day after operation. The rubber tube draining the perirenal region was removed on the same day. Four days later leakage of urine ceased to come from the wound, and the patient continued to do well. Before removal of the ureteral catheter on the sixteenth day after operation, a differential phthalein showed 60 per cent in 2 hours from urine voided (i.e., left kidney), and 28 per cent through the ureteral catheter from the right side. On the twenty-second day, as urine had ceased to escape from the wound, a total phthalein was done, and showed, appearance time, 6½ minutes, ½ hour readings of 34, 24, 15, and 10 per cent, total 83 per cent, as shown in the phthalein chart (Fig. 2). The patient remained in the hospital until December 27, and during this time the temperature was normal, and with the exception of vague slight pains, the patient was comfortable and in excellent condition. Cultures from the bladder on December 17 showed Gram positive cocci, and many Gram negative bacilli. The wound healed fairly satisfactorily, and was completely closed on discharge. Two days before discharge, 40 grains of iopax was given intravenously and X-ray films were taken after 15, 45, and 75 minutes. The 75 minute film was the best (Fig. 1, *3*) and showed very definitely that the dilated pelvis had been eliminated on both sides. On the left side the pelvis measured 8 by 2 centimeters. On the right side the pelvis was entirely intrarenal, but the kidney was still considerably enlarged, and the major and minor calyces considerably dilated, forming a lobulated shadow, which measured 10 by 3 centimeters. The renal cortex was distinctly thicker than it was before operation. The ureters were not dilated and the bladder is negative.

This plate shows that the obstruction has been completely removed on both sides, and that the kidneys have definitely improved since operation, and that there is no return of pelvic dilation.

On discharge, December 27, patient was in excellent condition. The phthalein test showed: appearance time, 6 minutes; ½ hour readings, 28, 28, 34, 8, total 98 per cent.

April 27, 1931, the patient returned for observation. He had been entirely comfortable, and had gained steadily in weight. He then weighed 30 pounds more than before the operations had been carried out. He had had no pain in either kidney, no gastro-intestinal disturbance, and general health had been excellent. He had had no fever and micturition had been normal. He returned simply for clinical studies, because he was advised to do so, in order to determine the results obtained by the operations.

On examination the patient looked well, had gained considerably in weight, wounds were well healed. Urinalyses showed specific gravity, 1012; slightly cloudy urine; albumin, trace; no sugar and no red blood cells. Microscopic study showed three white cells per high power field. Culture showed fairly heavy growth of bacillus coli. No cocci were found on culture and on repeated examinations.

Cystoscopy was done on April 28. The bladder capacity was 400 cubic centimeters. The prostatic orifice was normal, the bladder negative. Both ureters were catheterized, and No. 7 catheters passed to kidneys without meeting obstruction. Urine escaped slowly in drops, showing no retention of fluid in either pelvis. In one half hour 40 cubic centimeters of urine was collected from each side, and during this time the phthalein test showed on the right side, appearance time 9 minutes, and output of 6 per cent; on the left side, appearance time 4 minutes, and an output of 30 per cent, a total of 36 per cent for the first half-hour for both kidneys, indicating that the total function was very good. Cultures showed bacillus coli. It was thought unwise to make pyelograms, but it was decided to obtain information as to the size of the pelvis, by intravenous pyelography. Accordingly on April 30, iopax, 40 grams, was injected, intravenously, and X-ray films were taken, 15, 30, 45, 60 minutes, 2 and 5 hours after injection. The film taken 60 minutes after injection is apparently the best (Fig. 1, *4*), and shows that the right renal pelvis has become smaller since discharge from the hospital. It now measures 6 by 1.5 centimeters. There is no evidence of obstruction at the ureteropelvic juncture. The kidney appears about normal in size. The kidney has become distinctly thicker, the

cortex measuring from ½ to ¾ inch. There is no extrarenal dilatation of the pelvis. The major and minor calyces still show an irregular dilatation, but this has become distinctly smaller since discharge from the hospital, and now measures about 10 by 3 centimeters. The ureter on both sides is negative.

August 19, 1931, patient returned for examination. He has been carrying on active university work and plays one or two sets of tennis a day. He has very slight left kidney pain when riding in an automobile. He has gained 10 pounds in weight. Forty grams of iopax was injected intravenously and films taken 15, 25, 35, and 90 minutes after injection showed considerable diminution in size of the calyces on the right side. The kidney pelvis was not visualized. On the left side the kidney pelvis remained small and contracted. Cystoscopy was done, with bilateral catheterization. No. 7 catheters passed into the pelvis of each kidney without difficulty. Twenty cubic centimeters of urine drained from the right catheter in 5 minutes; 10 cubic centimeters, from the left ureter in 3 minutes. Specimens from each kidney were sterile. Phthalein test showed: left, appearance time, 2½ minutes; first half hour 125 cubic centimeters, 25 per cent; second half hour 25 cubic centimeters, 10 per cent; total 1 hour, 35 per cent; right, appearance time, 3½ minutes; first half hour 110 cubic centimeters, 10 per cent; second half hour 100 cubic centimeters, 10 per cent; total 1 hour, 20 per cent: transvesical phthalein 1 hour, 2 per cent; total phthalein output 1 hour, 57 per cent. Bilateral pyelography carried out with iopax showed the following: The kidney calyces and pelves were visualized on both sides, but no shadows at the ureteropelvic junctures were obtained. The ureters below this point were not dilated.

Case 2. Unilateral hydronephrosis due to obstruction at the ureteropelvic juncture by aberrant vessels to lower pole of kidney. Use of same plastic procedure to avoid injury of either vessels or ureter, and to separate them widely. Complete success, as shown by subsequent urograms.

H. B., B. U. I. 20430, male, aged 14 years, was admitted February 17, 1931, complaining of pain in the left side, of 8 months' duration. Patient has had chicken-pox, measles, pertussis, and swollen glands. Tonsillectomy was done at the age of 3 years, with excellent results. The past history was otherwise negative. Patient has always enjoyed good health. Eight months ago, immediately after the boy had turned a somersault, he noticed a fairly severe, acute pain in the left flank beneath the ribs. He ate dinner, and 2 or 3 hours later, the pain became quite severe, and nausea came on. The pain continued for about 24 hours, gradually getting less and then disappearing. The pain did not radiate, it was not associated with hæmaturia, and the patient passed no calculus. There was no pain in the opposite side, and micturition was normal. No physician was consulted, and no morphia was given. After that the patient was free from pain and discomfort for a month. He then had a second attack of pain similar to the first (but it did not follow athletic exercise). This attack was also associated with nausea and vomiting. It again lasted for about 24 hours. After that the patient had similar attacks about once a month, but during the last month he has had four attacks, two within the past week, and during these the patient found that if he made pressure on the left side the pain became very severe in intensity and knife-like in character. The pain was always localized to the left costovertebral angle and beneath the ribs on the left side. It never radiated, and was never associated with any abnormality of micturition, or with chills or fever. His general health remained good.

Six days before admission the patient was examined in the medical dispensary of the Johns Hopkins Hospital. The only positive finding was a spina bifida. The urine was reported normal. The patient was then referred to the Department of Neurology to see whether the spina bifida could account for the pain, and the report received was "examination negative in neurology." On the next day the patient came to the out-patient urological dispensary where again the physical examination and urinalyses were negative. Neither kidney was palpable or tender. As the pain suggested something renal, the patient was sent to the Brady Urological Institute, where an intravenous injection of iopax, 40 grams, was given. X-ray films were taken 5, 15, 30, and 45 minutes later and showed a large hydronephrotic left kidney with evident obstruction at the ureteropelvic juncture (Fig. 10, *1*). The right kidney was apparently normal. The bladder was normal.

The patient was then admitted to the hospital. At that time he gave no symptoms. The last attack of pain was 3 to 4 days before, again associated with nausea and vomiting, not radiating, and with no urinary symptoms.

Examination revealed an apparently normal, but somewhat undersized, boy. The chest was negative. The abdomen was symmetrical, no enlargement was visible. There was no rigidity of the abdominal muscles, no abnormality of organs, no masses were felt, no tenderness, and no muscle spasm was produced by the examination. Although the iopax had shown marked hydronephrosis on the left side, it was impossible to feel the kidney. No tenderness was elicited. The region of bladder, genitalia, rectum, and prostate was negative. Urinalysis disclosed the urine to be acid; specific gravity, 1010; no sugar; no albumin; no casts; no white blood cells; no red blood cells; no bacteria; and microscopically negative. Phthalein test showed appearance time, 5 minutes; ½ hour readings, 45, 15, 15 and 10 per cent. The output at end of 2 hours was 85 per cent. Cultures from urine were negative. The blood urea was 32 milligrams per 100 cubic centimeters. Blood pressure was 112–75.

Cystoscopic examination was made. The cystoscope entered easily. The bladder was found to be normal, and the ureteral orifices normal. Urine from the right side was slightly cloudy (traumatic). Phthalein appeared in 4 minutes, and output was 32 per cent. Urine from the left side was clear and phthalein appeared in 12 minutes, trace ("1.5 per cent"). A retrograde pyeloureterogram was made after 12½ per cent sodium iodide was injected and confirmed the findings obtained by intravenous iopax injections. The catheter passed up to the ureteropelvic juncture, but apparently did not enter the pelvis. Although hydraulic pressure was used in filling the ureter, very little of the fluid went into the pelvis. This was probably due to obstruction at the ureteropelvic juncture. Most of the sodium iodide flowed back into the bladder, as shown in Figure 10, *2*. As seen here the pelvis and calyces are not filled, but at the ureteropelvic juncture there is a pronounced kink and compression of the ureter.. (At operation this was proved to be a cord that contained artery and vein which ran from the great vessels to the lower pole of the kidney.)

Cultures were reported sterile.

After reviewing the history of the patient, and studying the X-ray films, it seemed evident that there was a left side hydronephrosis, apparently caused by an obstruction at the ureteropelvic juncture. The etiology seemed uncertain, as the pain began 9 months ago, following a somersault. The attacks were becoming more frequent, more intensely painful, and being accompanied by nausea and vomiting, were, in our opinion, sufficiently severe to warrant operative intervention.

On February 25, 1931, operation was done by H. C. Smith. Ether anæsthesia was used. Exploration of left

kidney, discovery of a considerably dilated left renal pelvis, about 5 to 6 centimeters in diameter. The kidney was slightly enlarged. The ureter was normal up to near the pelvis, where it was crossed by a band containing artery and vein, which produced compression and acute flexure, as shown in Figure 11, *1*, *2*, *3*, a drawing made at the time by Mr. Didusch. As the condition was almost identical with that found in Case 1 (above described), I advised Dr. Smith to carry out the same plastic procedure, to excise the redundant pelvic tissue, and at the same time to separate the veins and ureter so as to prevent obstruction in the future. Dr. Smith had no difficulty in accomplishing this, as shown by the accompanying illustrations. A diamond-shaped piece (about 1.5 by 2 centimeters in size) was removed from the posterior aspect of the dilated pelvis (Fig. 12, *1*). Through this opening an inspection of the ureteropelvic juncture was made. There was no valve nor any obliquity at the ureteropelvic juncture, and a No. 7 catheter passed down the ureter without meeting any obstruction (the blood vessels having been raised from the ureter). A No. 12 ureteral bougie failed to pass, and Dr. Smith thought it wise to continue the incision, the lower corner of which was at the ureteral orifice, down the ureter so as to divide the ureter for about 5 millimeters. There seemed to be a definite thickening at the ureteropelvic juncture. It seemed to be muscular rather than fibrous. After division of the ureteral margin, a No. 12 bougie passed without difficulty into the ureter. The opening left by the pelvic resection and prolongation of 5 millimeters down the ureter was closed by placing a suture, first which included the lower end of the ureteral resection, and drew this up to the upper angle of the diamond-shaped wound, as shown in Figure 12, *2*. The operator then resected a portion of the anterior wall of the pelvis through a similar diamond-shaped incision, the area being a little smaller than that removed posteriorly (Fig. 13, *1*). This was closed by drawing the lower corner to the upper corner, as shown in Figure 13, *2*, chromic catgut again being used, and the suture completed with a continuous suture, as had been done posteriorly. The result of this plastic was to draw the veins distinctly away from the ureter and at the end of the operation, Dr. Smith estimated that the ureter was about 2 centimeters distant from the veins, and the pelvis had been reduced to normal size. Practically all the extrarenal pelvis had been removed. Decapsulation with fixation of the kidney was then carried out. The capsule was rolled like a cigarette, and, through this roll of capsule, No. 1 chromic catgut was used to fix the kidney in proper position with transfixion sutures posteriorly. As a result the kidney was in excellent position, the veins and ureter were well separated, the redundant pelvis was completely removed, and the ureteropelvic juncture was enlarged and well situated. No catheter was placed in the kidney pelvis. The rubber drainage tube from the region of the operation passed out through the upper angle of the wound, which was closed with interrupted chromic catgut, two layers for the muscles and fascia. The skin was approximated with interrupted fine black silk, with two stay sutures of silver wire, which included skin, subcutaneous fat, fascia, and muscles. The patient stood the operation well and was in good condition on his return to the ward.

Convalescence was uneventful except for slight distention and pyrexia. There was an escape of urine from the drainage tube for 10 days, after which the leakage ceased and the tube was removed. The sinus healed quickly and the patient was discharged. On March 15 the patient's condition was excellent. The phthalein showed an appearance time of 5 minutes, ½ hour totals, 70, 15, 10 and 5. The urine was normal and free from infection. On March 18, an intravenous injection of 35 grams of iopax was given and 3 X-ray films were taken 15, 30, and 45 minutes after injection. The 45 minute film was the best (Fig. 10, *3*), and showed that the dilatation of the pelvis had been relieved but the calyces were still markedly dilated. The shadow measured 10 by 5 centimeters, and was almost entirely intrarenal. The pelvis was about normal in size. The ureter was not shown. The right kidney, calyces, and pelvis were normal.

On March 19, patient was discharged. His condition was excellent. The urine was sterile. The wound healed, patient was free from pain and his general condition was excellent.

The patient was seen 1 month after operation, at which time he was free from pain and was enjoying excellent health. He was again seen a month later, and he was still in splendid health. Patient is to return shortly for studies to determine result obtained by operation.

CONCLUSIONS

Obstruction at or near the ureteropelvic juncture is not infrequently caused by vessels which run from the great vessels to the lower pole of the kidney. Two cases are reported in which these vessels caused an acute flexure, kinking and obstruction of the ureter, in one case bilateral and in the other unilateral. In the bilateral case the less affected kidney was operated on first, and the aberrant vessels obstructing the ureter were clamped, divided and ligated. This was followed by a distinct postoperative reduction in the kidney function on this side. At the second operation I carried out a new procedure (a plastic operation) by means of which it was possible not only to resect the very redundant pelvic sac but also in closing it to draw the ureter away from the veins so as to completely remove all possibility of obstruction. The result obtained in this case was completely satisfactory. The same procedure was carried out in the second case also with complete success. In the first case, drainage of a huge hydronephrotic sac was kept up for over a month by means of a retained ureteral catheter passing out through the penile meatus. This resulted in an amazing restoration of this kidney, which was previously functionless, to practically normal function, so that it was possible to save this kidney and to carry out the conservative plastic of the pelvis with excellent results.

FROM THE SURGICAL DEPARTMENT, MICHAEL REESE HOSPITAL

THE TREATMENT OF ACUTE EMPYEMA

RALPH BOERNE BETTMAN, M.D., F.A.C.S., CHICAGO

THE objectives in the treatment of acute empyema are: (1) the removal of pus; (2) the sterilization of the pleural cavity; and (3) the re-expansion of the lung.

In these fundamentals the treatment of an infection of the pleural cavity does not differ at all from that of an infection in bone or for that matter in almost any other tissue. The bi-products of the infection, that is the pus, must be removed, the site of infection must become sterilized, and finally the defect due to tissue destruction must be obliterated.

In the case of an empyema, the empyema contents are easily removed by any one of many operative procedures; the sterilization of the pleural cavity is brought about chiefly through nature itself; the obliteration of the infected cavity through the re-expansion of the lung.

The fact that in empyema a very large non-collapsible cavity must be obliterated differentiates the infection of the pleura from infection in other parts of the body.

The rising of the diaphragm, the pulling together of the ribs, and the thickening of the pleura account for only a very minimal part of the obliteration of the cavity. Until the lung re-expands sufficiently to fill the pleural cavity, the infection usually remains. This re-expansion of the lung is without doubt the most important factor in determining the final recovery of an acute empyema.

It is obvious that any method of treatment which facilitates the re-expansion of the lung reduces the period of morbidity, while any method of treatment which allows the lung to remain collapsed lengthens the morbidity. The lung, as we all know, is an elastic structure which tends to collapse and is held to its expanded size by the negative pressure in the chest. We know that once the pleural cavity is opened and air is allowed to rush in, the natural elasticity of the lung will exert itself and the lung will collapse. In the case of an empyema, the lung has already partially collapsed because the purulent products of the empyema have taken up some of the space it formerly occupied. It stands to reason, therefore, that a method of attack upon acute empyema which not only will remove the pus from the pleural cavity and allow the pleura to sterilize itself or perhaps even aid in the sterilization, but will hasten the process of re-expansion of the lung, is the ideal procedure. By the so called "closed method" of treatment, these three desiderata are attained.

THE PHYSIOLOGICAL REASONS FOR THE CLOSED METHOD

There are several physiological reasons why the closed method of treatment is preferable to the open method. As we said before, the lung is naturally contractile and the only thing which keeps it expanded to occupy the pleural space is the negative pressure within the chest cavity. As soon as an opening is made into the chest wall, air can rush in and allow the lung to collapse. Contrary to long established opinion, the mediastinum is a very flexible structure. It is, therefore, easily pulled over to the opposite side, thus allowing the opposite lung also to contract. Therefore, the first result following an open pneumothorax is a decrease in the volume of both lungs which in turn means a decrease in the amount of air which the lungs contain. As we know, a patient who is sick and has a fever has an increased metabolism, that is, uses more oxygen and, therefore, it is obvious that a decrease in vital capacity is diametrically opposed to his requirements. Furthermore, in the great majority of cases of empyema, the vital capacity of the patient is already diminished by the presence of exudates in the alveoli. Any further reduction in vital capacity might be harmful even in the absence of an increased oxygen need. In the presence of an open pneumothorax, there is a great deal of to and fro motion of the mediastinum because with each inspiration it is sucked over to the good (closed) side of the chest as air enters through the thoracotomy wound and with each expiratory effort it is forced toward the wounded (open) side as the good lung becomes compressed. (Expiration in the presence of an open pneumothorax of any extent ceases to become a passive phase and becomes an active effort.) This to and fro swinging of the mediastinum causes a great deal of shock. An open pneumothorax permits a very speedy evacuation of the pleural cavity with an abrupt change in the intrapleural pressure. Such quick changes are frequently dangerous.

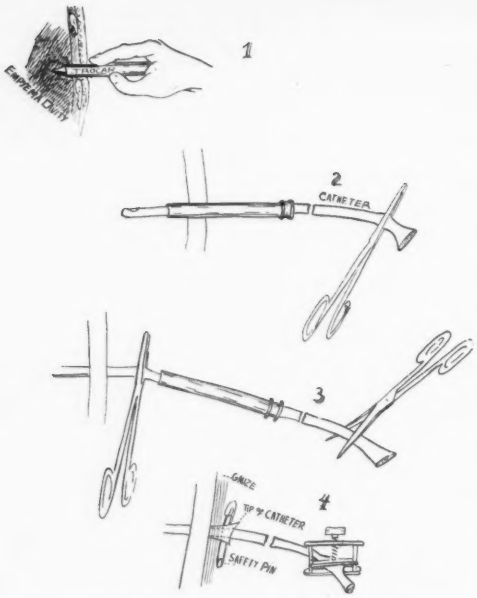


Fig. 1. Method of introducing catheter. Modified from Internat. Clin., 1923, i.

As we said in the first paragraph, the empyema is finally healed when the empyema cavity becomes obliterated. Any procedure which allows the lung to collapse more than it already is, naturally lengthens the morbidity. In the closed method of drainage, the lung is actually sucked out; for with each cubic centimeter of pus which is aspirated an equivalent expansion of the lung must occur to take its place.

The closed method of draining an empyema is the most physiological inasmuch as it disturbs least the mechanism of respiration, and is the most ideal from the point of view of shortening the disease inasmuch as it actually aids in the re-expansion of the collapsed lung.

WHEN TO START TREATMENT

There are certain objections to starting the treatment of empyema too early. In the first place, it must be emphasized that the presence of fluid, even an apparently infected fluid, in the pleural cavity during the course of a pneumonia, does not constitute an empyema from the point of view of therapeutics. At some time during almost every case of pneumonia there is an increase in pleural fluid. This fluid may frequently be turbid, usually contains pus cells, and very frequently, when cultured, will reveal the presence of living organisms. In the majority of cases of pneumonia, the presence of this fluid is never discovered and the fluid itself absorbs without any untoward results. Obviously no treatment other than the pneumonia treatment is required. Occasionally this fluid may increase to such an extent that the pressure on the mediastinum and on the heart causes respiratory and cardiac embarrassment. In this case, sufficient fluid and only sufficient fluid should be aspirated to relieve the embarrassment.

It is probable that the increase of pleural fluid during pneumonia is a natural protective reaction; the pleura and the lung lying directly under being thus protected from friction, and furthermore by occupying part of the pleural space the lung is allowed to contract and therefore become partially immobilized. It is just as beneficial for infected lung tissue to remain quiet as it is for infected tissue in any part of the body.

Therefore, one of the chief axioms in the treatment of empyema might be:

Delay treatment if possible until such time as the infection in the lung (pneumonia) has subsided.

It is frequently very difficult to decide exactly when the pneumonia has disappeared and the empyema has become responsible for the patient's symptoms. In cases in which the pneumonia terminates by crisis and in which a period of several days of improvement follows before the empyema symptoms arise, the question is an easy one. But in cases in which the symptoms from the pneumonia seem to be prolonged into the symptoms evidently produced by the empyema, the question is not so easy. Dullness on percussion can be caused by a serous fluid as well as a purulent one. Pressure on the lung from the fluid can produce bronchial breathing. Moist râles will remain long after the pneumonia has subsided. As a rule a patient's condition improves after the pneumonia and stays improved during the early course of the empyema. Generally the respiratory rate in the early weeks of the empyema is slower than in the pneumonia, although in cases in which a large amount of fluid is present this may not be true. The X-ray will show the presence of even small amounts of fluid, but a large fluid accumulation may completely cover a lower lobe pneumonic consolidation. Probably the best single sign which will aid us is the temperature. The temperature of a pneumonia is an irregular temperature but usually a sustained temperature which never reaches normal. The temperature in an empyema is usually a well defined septic

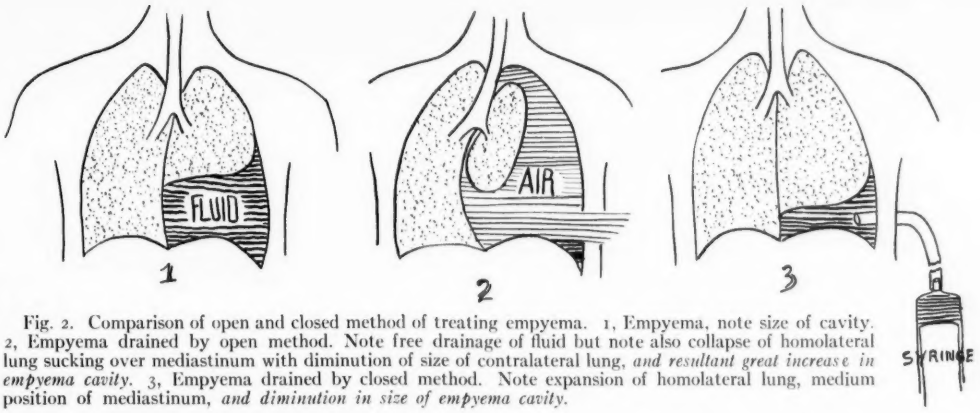


Fig. 2. Comparison of open and closed method of treating empyema. 1, Empyema, note size of cavity. 2, Empyema drained by open method. Note free drainage of fluid but note also collapse of homolateral lung sucking over mediastinum with diminution of size of contralateral lung, *and resultant great increase in empyema cavity.* 3, Empyema drained by closed method. Note expansion of homolateral lung, medium position of mediastinum, *and diminution in size of empyema cavity.*

temperature coming down to normal or nearly normal once a day, usually in the morning and reaching a high point usually in the later afternoon or evening. Of all the signs, the septic temperature is probably the one that is most indicative that the empyema is now the important factor. The actual appearance of the fluid is helpful. For many years it has been known that in cases in which the empyema contents were a frank thick pus the prognosis was favorable. This was due to several reasons, one of them being that by the time the fluid had reached this stage, the pneumonia was sure to have subsided.

WHERE TO DRAIN

In general terms drainage should be at a dependent portion of the empyema cavity. Naturally in cases of encapsulated empyema the site of drainage must be at the site of encapsulation. If the encapsulation is in front, drainage must be through the anterior chest wall; if on the side, lateral; and in back, posterior. The majority of empyemas involve a large area of the pleural cavity extending from the diaphragm upward toward or to the apex and reaching from the vertebral column laterally to or past the anterior axillary line. In such cases it is often a question where the most dependent portion of the pleural cavity is located. Innumerable sites of election for drainage have been advocated. The truth of the matter is that the most dependent portion of the pleural cavity varies with every motion of the patient, with every position that the patient assumes, whether lying or sitting or reclining. With a patient flat on his back, the most dependent portion of the pleural cavity is probably in the seventh, eighth, or ninth interspace in the paravertebral gutter. With the patient semi-reclining, the dependent portion drops down to the diaphragm. With the patient lying on the infected side, as patients usually prefer to do in the early stages of empyema, the dependent point moves laterally into the axillary region. It is thus obvious that other factors must guide us in our selection of the site of drainage. It is unwise to drain too low because, as the fluid is drained from the pleural cavity, the diaphragm, which is usually partially paralyzed by the inflammation of its pleura, rises and, therefore, obstructs the site of drainage. It is best not to drain in the very posterior portion, because if the patient lies on his back, the drainage tube may be uncomfortable and also may be compressed by the weight of the patient.

I usually prefer draining somewhere in the eighth or ninth interspace in the posterior or midaxillary line. By using this site, I get the advantage of larger interspaces and more easily accessible ribs and a site of drainage which is adequately dependent especially if the patient is lying turned slightly on the diseased side and yet not at a place where the drainage tube is apt to be compressed. When the patient resumes a sitting or standing posture toward the end of the disease, the site of drainage is usually low enough in the thoracic space to take care of even small amounts of fluid and yet not low enough to be covered by the diaphragm.

MULTIPLE ASPIRATION

A closed method of treating empyema is by means of multiple aspirations. It has been known for years that very occasionally a patient will apparently remain cured after one, two, or a few aspirations of pus from the pleural cavity. Multiple aspiration was used in the early period of the war and in the days before the war to stave off

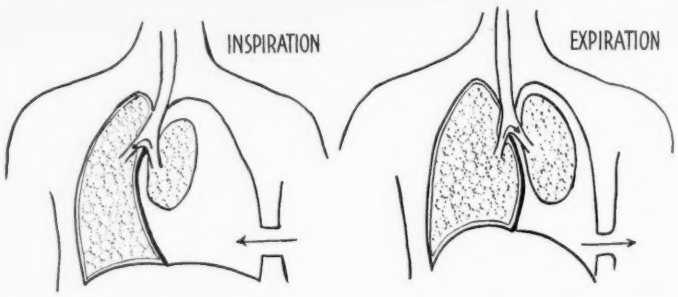


Fig. 3. Schematic drawing of an open pneumothorax. Note swing of mediastinum, collapse of both lungs, *pendel-luft*, during forceful inspiration and expiration. Modified from Am. J. Surg., 1929, vl, No. 4, April.

the operation of rib resection until such time as it was felt that pleural adhesions had been formed of sufficient strength to stabilize the lung. To my knowledge Dr. Brenneman, of Chicago, was the first in this country to show a large series of cases in which cures were obtained in the great majority simply by aspiration.

The technique is easy. A thoracentesis is performed, and by means of a large syringe the pleural contents are aspirated. If the aspiration is done slowly and the underlying lung is no longer in a stage of active inflammation, large quantities of fluid may safely be aspirated. As the fluid re-accumulates, the chest is again aspirated and so on until the patient is finally cured or some other form of treatment is instituted.

In my own experience only a very small proportion of patients get well with aspirations alone. I personally have found that the insertion of a tube into the chest can be accomplished with very little more discomfort than the insertion of the aspirating needle and I think a single tube insertion is preferable to repeated aspirations. In infants in whom it may be difficult to insert a tube because of the small size of interspaces, the aspiration method of treatment has its greatest value.

I personally have had no experience with some of the more recently reported methods, such as aspiration of pus and replacement of air or aspiration of pus and replacement of fluid. It seems to me that these methods are much more complicated than the method which I am going to describe next and therefore I can see no advantage in them.

In older children or in adults I resort to repeated aspirations only when for some reason or other tube insertion is impractical.

THE TROCAR METHOD

The simplest method of instituting closed drainage and the one method that I use in the large majority of children and adults is the trocar method.

The site of drainage is determined and the skin over the area is carefully prepared with alcohol, ether, and iodine. A small wheal is made on the skin with novocain and the interspace infiltrated by pushing the needle through the skin and subcutaneous and muscle tissues into the pleural space. A small amount of the empyema contents is aspirated into the syringe in order to prove without doubt the presence of the empyema. In a thin individual, the needle can now be withdrawn, the site of the puncture being marked by a finger pressed firmly in the interspace. In a stout individual, in whom it is impossible to feel the ribs, it is best to leave the needle in place as a guide.

With a fine scalpel, the skin is niched so that the trocar can be passed easily through it. Holding the trocar firmly in the right hand with the index finger extended to act as a check against a sudden thrust into the pleural space, the trocar is firmly but gently pushed through the infiltrated intercostal space into the empyema cavity. Its puncture through the pleura is usually easily realized by the sudden loss of resistance. The catheter, carefully tested before the operation and found to fit snugly into the sheath of the trocar, is now clamped with one of the hæmostats at its flaring edge; the tip is immersed in sterile glycerin; and the assistant, holding it by the hæmostat, lifts the catheter so that the tip is in close proximity to the end of the trocar. The obturator is withdrawn from the trocar and the catheter is immediately inserted. After the maneuver has been rehearsed a few times before

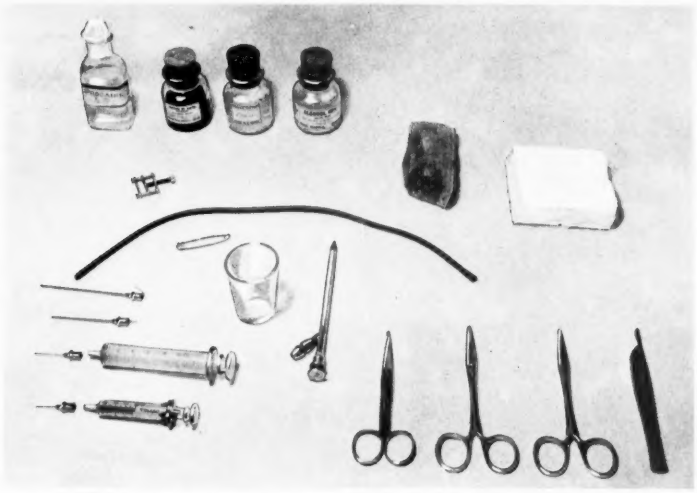


Fig. 4. Tray set up for drainage of empyema cavity by the closed trocar method.

operation, it will be found that the catheter can be inserted into the trocar in a split second allowing practically no time for the aspiration of air into the pleural cavity.

Almost the entire length of the catheter is threaded in through the trocar into the pleural cavity. The trocar is now gently pulled out of the chest wall and the catheter is clamped at its emergence from the chest wall with a second hæmostat. The first hæmostat is opened, the flaring end of the catheter is cut off, and the trocar is completely removed. In this way, catheter drainage of the empyema cavity has been speedily instituted with a minimum of effort and in an air-tight manner.

I use the flaring edge of the catheter, which has been cut off, as a washer. I rethread it on the catheter and push it down until it fits snugly against the small wound in the chest. It will be found that this will hold the catheter firmly. A safety pin is passed through this washer, a small bit of gauze is laid below the safety pin, and by passing two adhesive strips over the pin, the catheter is securely anchored without having the pin forced through the catheter itself. The washer does not hold the catheter so firmly but what it can either be pulled out or pushed further into the chest at will. I usually leave from 3 to 5 inches of catheter lying inside the empyema cavity. It is easy to ascertain the length of catheter inside the cavity by comparing the length of catheter extending from the chest wall with another catheter of similar length. For convenience's sake a small laboratory clip is substituted for the hæmostat to close the catheter. A light binder is applied to the patient's chest, held by two shoulder straps, a hole in the binder permits the end of the catheter to protrude, and a little pocket holds the catheter and the clip. Thus the end of the catheter is easily accessible.

I should have mentioned when speaking about the anæsthetic that in most children a lollypop given at the beginning of the procedure usually acts as a splendid placebo.

THORACOTOMY METHOD

Occasionally, in larger children and in thin adults, I use another similar method of tube insertion which admits the use of a much larger tube. The drainage tube in this case consists of a No. 24 F. or even larger self-retaining Pezzer catheter.

A small bit of silver tubing about 2½ inches long, that is, just long enough to fit through the chest wall, is inserted into the catheter in such a way that it lies a fraction of an inch behind the tip. The diameter of this tubing is such that it fits very snugly and will be held firmly in place by the elasticity of the catheter itself. In order to prevent any possibility of the tube slipping a small perforation has been made in it so that it can be sutured to the catheter. The walls of this silver tube are very thin. The purpose of the tube is simply to prevent the muscles and the ribs from obliterating the lumen of the catheter. The catheter is inserted by means of a thoraco-

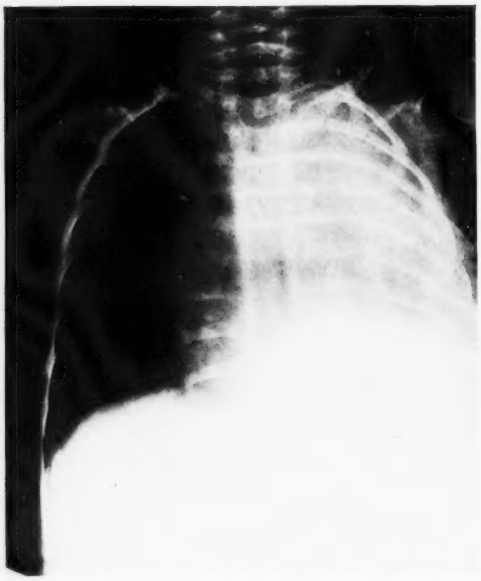


Fig. 5. Roentgenogram of typical empyema. Note lateral displacement of heart, and trachea.

tome which was recently brought over from Professor Forschwach's clinic in Breslau and demonstrated to me by Mr. Mueller. I had Mr. Mueller cut off the blades to give the instrument more power and at the same time to make it easier to handle. The thoracotome is somewhat on the order of the common bivalve vaginoscope, the two blades lying very close together when the instrument is closed. Running between the two blades is a third blade which is removable. The tip of the third blade has been sharpened to a knife edge and is cut in the form of a shallow spear. With the two lateral blades closed upon the median spear blade, the instrument can be used in very much the same way as a trocar.

The area is prepared and anæsthetized in a manner similar to the one described above. The presence of pus in the pleura is demonstrated as before. The incision of the skin is made for a length of about three-fourths of an inch, that is, large enough to allow the introduction of the thoracotome. The thoracotome is pushed through the interspace with its flat sides parallel to the ribs, more care must be exercised in forcing the thoracotome through the intercostal space because of the greater danger of injury to the intercostal vessels. When the pleural cavity has been entered, the Pezzer catheter is clamped and held in a manner similar to that already described. The blades of the thoracotome are quickly spread apart. The median blade or obturator is removed, and the catheter with its contained silver tube is plunged into the pleural space. The thoracotome is withdrawn and the catheter is thus left *in situ* in very much the same way as if it had been introduced by the trocar. The catheter is now pulled upon, so that the silver tubing lies in the interspace guarding the catheter from pressure of the ribs, and the bulging opening of the catheter lies directly against the pleura. The catheter is held in this position with adhesive.

The advantage of this method over the other is that a much larger drainage tube can be used. The disadvantages are, that in stout persons where the interspaces are not easily palpable, there is more danger of injuring the intercostal vessels.

Occasionally a modification of this technique is necessary in cases in which the interspaces are small. In these cases a portion of the rib is removed subperiosteally and then the thoracotome is pushed through the posterior costal periosteum and pleura into the empyema cavity. After the thoracotome has been removed, the skin wound is closed about the catheter.

AFTER-TREATMENT

The after-treatment requires much care and constant supervision.

After the catheter is in place, sufficient pus is removed with a syringe to overcome any respiratory embarrassment which the patient may have had. The pus is removed carefully so that the intrathoracic pressure relations are not too speedily altered. In children, 250 cubic centimeters of pus is usually the maximum amount removed; in adults, twice that amount, provided, of course, the cavity is large. Thereafter, the pleural cavity is aspirated through the tube about every 3 hours, the nurse being carefully instructed to allow no air to gain access to the pleural cavity during these aspirations. The best way of enforcing this is to give the order that the tube clip is not to be removed from the catheter until after the aspirating syringe has been put in place and is to be re-applied to the catheter before removing the aspirating syringe to eject its contents. As much pus as can be aspirated is removed, although in children I have found it safe to place a maximum of 100 cubic centimeters. After the pus has been removed, Dakin's solution of chlorinated soda is re-injected into the pleural cavity. The reason for injecting the Dakin's solution is not so much to sterilize the empyema cavity as to dissolve the thick flakes of fibrin which are found in the fluid.

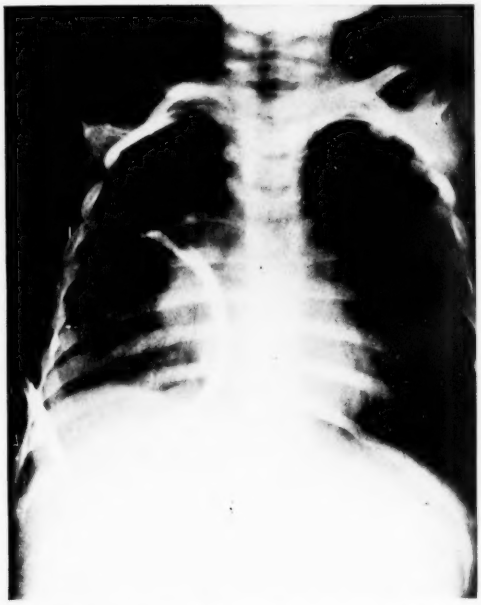


Fig. 6. Roentgenogram showing empyema with tube in place. Note upward course of catheter and absence of lung collapse—compare with Figure 6A.

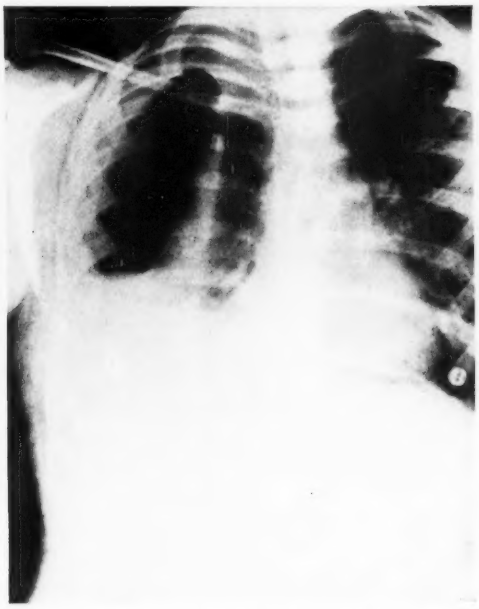


Fig. 6A. Empyema treated by rib resection and open drainage. Note collapse of lung.

Dakin's solution liquefies the contents of the empyema cavity better than any other fluid we have at our disposal. I have tried various solutions, but have come to the conclusion that the full strength Dakin's solution, such as we used during the war, is apparently the best solvent. Incidentally there is no such thing as full strength, half strength, etc., etc., Dakin's solution. Dakin's solution is a specific solution of chlorinated soda, titrated to a definite point and in a proportion such as to yield a definite amount of chlorine. I have adopted as an arbitrary measure for the amount of Dakin's solution to be re-injected into the cavity after each aspiration, one-third the amount of pus that is aspirated. If the pus aspirated is very thick the amount of Dakin's solution is one-half that aspirated. As a rule, the patient is not awakened at night to be aspirated at stipulated times, but the aspirations and the injections are made at about 3 hour intervals, such times as the patient happens to be awake being chosen. After a few days, especially if the tube has been inserted laterally instead of posteriorly and is, therefore, accessible, the aspirations and injections can often be made without arousing the patient.

When the patient's temperature has dropped to normal and his general condition is such that he can be ambulatory, he is allowed to get out of bed. Children are sent to the playroom in wheel chairs as soon as possible. Not until several days after the fever has completely subsided can heliotherapy be given with safety. However, after this time it is recommended if the patient's condition demands it. A high caloric diet is often useful in patients who have been emaciated by the severe previous illness. Exercises, such as bending and reaching, are very helpful in the later stages of the empyema in correcting the tendency toward scoliosis. These exercises, however, are not actually necessary because in the usual case of acute empyema treated by the closed method, no lasting deformity results. The slight scoliosis which is frequently present at the end of treatment is entirely corrected within a week or two, after the child has been turned loose and allowed to play normally.

The use of some artificial means to expand the lungs, such as blow bottles, is seldom indicated in acute empyema when treated by the closed method. If, however, the lungs seem to be fixed and, in spite of aspirations, cannot be expanded, blow bottles may be used. A blow bottle consists

Fig. 7. Empyema binder. Note perforation for emergence of catheter and pocket in which catheter can rest. This case happens to be a case of bilateral empyema treated by the closed trocar method of drainage.

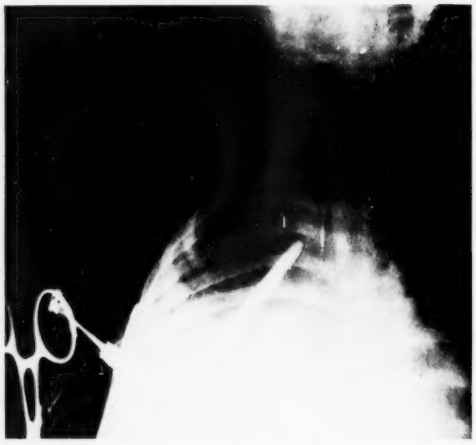


Fig. 8. Empyema at end of treatment. Note complete lung expansion.

of a set of ordinary laboratory flasks which are so attached that the patient forces water from one bottle to another by blowing on a tube. The contraction of the chest wall and the elevation of the diaphragm with pressure against the air within the lungs, such as occurs in blowing, tends naturally to decrease the size of the empyema cavity. It stands to reason, of course, that while the patient is blowing, the drainage tube must be open. This is best accomplished by placing the end of the catheter in a bottle partially filled with fluid, the end of the catheter being well below the fluid line. In this way, as the chest cavity contracts, the contents of the empyema cavity can be forced outward and yet air cannot be sucked into the empyema cavity during the subsequent inspirations. The point should be stressed because I have frequently seen patients given blow bottles and put to work, the attendant at the same time forgetting to open the drainage tube. The result is that the fluid in the empyema cavity being non-compressible, the empyema cavity becomes not the slightest bit smaller through the forced contraction of the chest, but, on the other hand, proportionately larger as compared to the lung. In our children's wards we color the liquid in the blow bottles a different color every day. We frequently make use of a litmus solution as the fluid and change the acidity in the bottles.

The dressings around the empyema tube are changed whenever they become soiled. As a rule, the dressings can be left untouched for the first week. After that time a small rim of granulation tissue is apt to form about the catheter and a slight amount of seepage may necessitate a daily change of dressing; change of dressing consisting only of removing the soiled piece of gauze and applying a fresh one. This rim of granulation tissue should not be cauterized for two reasons: In the first place, I do not believe that cauterization of "proud-flesh" accomplishes much in any type of wound and, in the second place, the granulation tissue, in this instance, acts like a valve, allowing perhaps a small amount of seepage from the wound during expiration, but closing down around the tube during inspiration.

Occasionally toward the end of the treatment, the aspirations may be bloody. This is usually due to trauma to the granulation tissue arising about the tube. As a rule this has no significance and requires no change in the treatment. If the aspirations are very blood tinged it is advisable to aspirate less frequently and to substitute normal saline instead of Dakin's solution for the instillation.

The fever is frequently increased the first day or two after the tube insertion but by the third day usually commences to drop and before the week is up may be nearly normal.

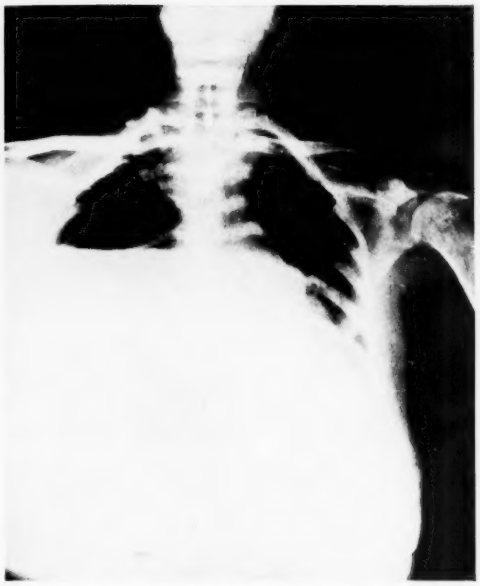


Fig. 9. Roentgenogram in upright position. Empyema with bronchial fistula. Note fluid line.

Fig. 10. Drainage of empyema by closed method in the presence of a bronchial fistula. Note tube leading into bottle filled with water. Air can come out of chest but none can enter. Tube is shown further below the water level than is used in actual practice for the sake of clarity. In actual practice tube should be less than 4 centimeters below the water line.

The well being of the patient usually improves a day or two after the tube is inserted and continues to improve steadily throughout the convalescence.

OBSTRUCTION TO CATHETER

Occasional difficulty in aspirating the empyema contents through the small catheter has been the chief objection to the closed method. Difficulty in aspirating the empyema contents arises from any one of four conditions.

1. A thick plug of fibrin is sucked into the catheter and obstructs it.

2. A thick flake of mucus and fibrin, or the lung itself is sucked against the opening of the catheter and thus occludes it.

3. The contents of the empyema cavity instead of being fluid consist of thick inspissated masses resembling pseudo-membranes.

4. The catheter ceases to lie in the empyema cavity but lies between the lung and the chest wall.

The most frequent of the causes of obstruction is fibrinous plug. The empyema contents are usually rich in fibrin and a clot is frequently aspirated into the catheter. The catheter will usually be blocked at its tip. If enough suction is produced by the syringe the catheter will collapse. Occasionally it will be possible to suck the plug through the catheter down to the point of the syringe. In this case, of course, pulling back the plunger of the syringe will cause a vacuum in the syringe but will not collapse the catheter. In this case the fibrin is readily removed by clamping the catheter a few inches from the end and pulling free the syringe while the plunger is still maintaining the suction. The clot will adhere to the syringe.

In order to clear the catheter it is only necessary to force through it 2 or 3 cubic centimeters of Dakin's solution. In certain patients the tendency to form fibrinous clots is greater than in others and in these cases it is advisable to instill a greater proportion of Dakin's solution after each aspiration and to aspirate more frequently.

The empyema cavity almost invariably contains flakes of fibrin. These flakes are often aspirated into the mouth of the catheter. The more suction applied by the syringe the more securely these flakes will close the catheter mouth.

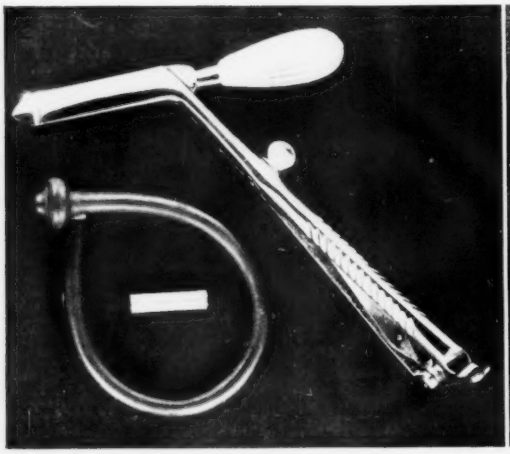


Fig. 11. Modification of Forschwach thoracotome. (Instrument closed, ready for insertion.) Pezzer catheter and silver tube.

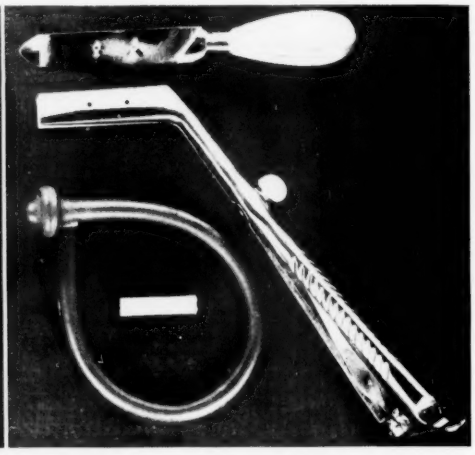


Fig. 11A. Modification of Forschwach thoracotome. (Instrument open, blades spread apart, central blade removed.)

As soon as the suction is released the fibrin flake is also released. Often the mouth of the catheter lies close enough to the lung so that if forceful suction is made it will be pulled against the catheter opening and will block the drainage. In these instances it will be found that solutions can be easily injected into the chest but that on aspirating the tube becomes clogged and collapsed. Very gentle suction, however, will often be successful in aspirating fluid. Gentle suction cannot be made with a large syringe. For this reason on my service the nurses never aspirate through a syringe larger than a 10 cubic centimeter Luer and in case of occlusion change to a 2 or 5 cubic centimeter syringe. Another way of aspirating with the minimum of suction is to fill the catheter with Dakin's solution and then submerge the end of the catheter in a tumbler partially filled with fluid and held several inches below the point of emergence of the catheter from the chest. In this way the chest contents can be siphoned out with a pressure of but a few centimeters of water, a pressure which will not suck the lung against the opening of the catheter with sufficient force to occlude it. If the catheter is against the lung, occasionally turning it will direct the lateral opening toward the cavity.

Fig. 12. Roentgenogram showing a large encapsulation, left upper pleura.

Contrary to what one might surmise, the tip of the catheter instead of falling down toward the bottom of the chest cavity when it is inserted strikes the oblique surface of the lung and is forced upward toward the apex. This is not at all detrimental and in fact may be beneficial because the injected Dakin's solution thus comes into contact with a greater pleural surface. However, as the treatment continues and the empyema contents diminish and with it the lung is expanded,

it will frequently occur that the catheter lies pinched between the expanded lung and the chest wall well above the empyema. In this case aspiration merely sucks one or the other of the pleural surfaces into the mouth of the catheter. This condition is easily recognized by X-ray. To overcome this condition it is only necessary to withdraw the catheter a few inches. As the treatment continues the catheter will again have to be withdrawn. In other words, during the treatment of empyema by the method I have described the catheter should be gradually withdrawn. In the cases in which a Pezzer self-retaining catheter is used this will not be necessary because the opening of the catheter lies low down and against the chest wall from the very start.

The following are the standing orders for nurses on my service, when difficulty in aspiration occurs in empyema cases with catheter drainage.

1. Always use a small syringe (10 cubic centimeter Luer) and aspirate as gently as possible.
2. If unable to aspirate with the usual syringe, try a 2.5 cubic centimeter (hypodermic) syringe.
3. If still unable to aspirate inject 5 cubic centimeters of Dakin's solution. If the Dakin's solution is at first difficult to inject and then flows in easily it shows that the catheter is plugged. After the solution has been injected, gentle aspiration with small syringe or with siphonage should be tried. If still unable to aspirate, instill into the chest cavity an amount of Dakin's solution approximately equivalent to one-half the largest amount which has been aspirated at any one time during the last 24 hours and aspirate in an hour. The amount should be instilled only provided the Dakin's solution flows into the chest with but the slightest pressure on the syringe.
4. If the subsequent attempt to aspirate is also unsuccessful the interne should be called.
5. Force should never be used in aspirating.

WHEN TO STOP TREATMENT

I have one and only one criterion when to *stop treatment* and that is, *when the empyema cavity is obliterated*. The absence of fever, the improvement in the general condition of the patient, the clearing up of the empyema contents, are all important signs, but none of them can be relied upon as an indication for stopping treatment. The same applies to the careful bacteriological studies of the fluid aspirated from the empyema cavity such as were made during the war and which are still advised by some. No matter how sterile the fluid may be, if the cavity is not completely obliterated, removal of the tube will be followed in all too high a percentage of cases by recurrences of empyema.

The method of ascertaining when the cavity is obliterated is simplicity itself.

When no more fluid can be injected into the catheter without immediately returning around the sides of the catheter, or actually forcing the catheter out of the chest wound, then the cavity is obliterated.

The length of time for the obliteration of the cavity varies in individuals all the way from 6 days to several months. As a rule, it is safe to tell the patient that the tube will be out in 6 weeks. This usually is from a week to 2 weeks longer than it actually takes, but I have found that a patient is much happier when the treatment is shorter than anticipated, even though the period he expected might have been a comparatively long one.

TREATMENT IN THE PRESENCE OF A BRONCHIAL FISTULA

At least 10 per cent of acute empyemas in infants and a smaller percentage in adults are complicated, either from the beginning or at some time during the early part of their course, by the presence of a bronchial fistula.

The presence of a bronchial fistula can be determined by the fact that the patient coughs up large amounts of purulent material which frequently may be stained, if mercurochrome or gentian violet is injected into the empyema cavity; and by the fact that when the clip has been removed from the catheter and the patient is made to cough, large quantities of air will be forced out of the catheter along with the pus. Often the first sign of a bronchial fistula will be a paroxysm of coughing, following the instillation of Dakin's solution, and the complaints from the patient that he can taste the solution.

If the X-ray discloses a straight fluid line before drainage has been instituted, that in itself is pathognomonic of a bronchial fistula. Incidentally, it is surprising how often this is overlooked. In the non-air-containing pleural space the fluid line is usually indistinct and curving. A sharp, straight fluid line is indicative of fluid with air over it. It is for this reason that X-rays of the chest must be taken in the upright or lateral position.

The treatment of an acute empyema complicated with a bronchial fistula differs from the treatment that I have outlined only in this manner; that a valve is placed at the end of the catheter so that fluid and air can easily escape from

the chest cavity and yet nothing can be sucked into it. The easiest method of constructing such a valve is to attach a 3 foot length of soft rubber tube to the end of the catheter, and allow the end of this tube to fall in a glass jar which stands under the bed, or, if the patient is ambulatory, carried around supported from a sling. This jar is partially filled with some antiseptic solution such as permanganate, and the end of the rubber tubing is always kept below the fluid level. In this way, the air and fluid contents are given free egress from the chest and yet air from the outside cannot gain access to it. Thus all danger of pressure pneumothorax is avoided.

Instead of installing Dakin's solution into the empyema cavity, the cavity is irrigated twice a day with normal saline or boric acid solution. If this produces a paroxysm of coughing, the irrigations are stopped entirely.

The average bronchial fistula, being an attempt of nature to drain the empyema cavity spontaneously, closes very promptly after artificial drainage has been instituted and, as a rule, after from 24 to 72 hours, the usual form of treatment can again be carried on.

TREATMENT IN THE PRESENCE OF A BILATERAL EMPYEMA

Not infrequently following a bilateral pneumonia, a bilateral empyema will be present. In this case, treatment is carried out by the closed method as described. The advocates of the method of multiple aspiration have placed bilateral empyema in the class of cases in which no other type of treatment can safely be used. This is not true. I have never hesitated to treat bilateral cases of empyema exactly as unilateral cases and I have introduced the drainage tube either by means of the trocar or the thoracotome. Naturally, in hospitals in which the treatment of empyema is carried out in a careless manner and the aspirations and instillations are not done with due regard to the avoidance of the admission of air into the pleural cavity, the treatment in cases of bilateral empyema will carry an additional risk. However, where due care is used there is no more danger in the treatment of a bilateral empyema by drainage than in a unilateral empyema.

TREATMENT IN THE PRESENCE OF AN ACTIVE PNEUMONIA

It occasionally happens that the treatment for an acute empyema must be started, on account of the tremendous amount of accumulated fluid, while the pneumonia is still active or that a secondary pneumonia intervenes. The only variations in the treatment of those cases are the following: The aspirations should be done at more frequent intervals, so that smaller amounts of fluid can be withdrawn; as much fluid as possible should be left in the chest cavity so as to splint the diseased lung. In cases of active pneumonia, instead of adding only a third of the amount of Dakin's solution, it is wise to add Dakin's solution to the quantity of either one-half the amount of pus aspirated or to a quantity almost equivalent to that of the pus aspirated. If the pneumonia is very active it may be wise to refrain from using Dakin's solution and to substitute either sterile saline solution or boric acid in its stead so as not to irritate the pleura.

An oxygen tent or an oxygen chamber has been of the greatest help to me in these cases.

ENCAPSULATION

Encapsulation of a certain part of the empyema cavity is not an uncommon occurrence during the treatment of acute empyema. The encapsulation may occur in any part of the chest, and may be large or small. It rarely occurs during the early part of the disease.

In the majority of cases these encapsulations are in the nature of a fibrinous agglutination of the two pleural layers which break spontaneously under the increasing pressure of the accumulated fluid. Occasionally, however, the fibrinous agglutination becomes organized and a firm, fibrous encapsulation ensues. In such case the encapsulation will have to be drained.

The diagnosis of an encapsulation is made from the symptoms of the patient and may usually be verified by the X-ray.

The symptoms are a gradual recurrence of the septic temperature curve and a gradual decrease in the well-being of the patient. In every patient in whom after a certain period of normal temperature, or a temperature curve which is approximately normal, there again appears an increase in the afternoon fever, an encapsulation must be kept in mind.

Inasmuch as the encapsulation usually breaks up spontaneously and drains itself into the major empyema cavity, no treatment is called for for several days. It is only when the symptoms of encapsulation persist that treatment is indicated. The first step of the treatment will be to locate the encapsulation. The usual physical signs may be of little avail because of the already thickened pleura. The use of the X-ray, however, will usually show a large encapsulation. It may be necessary to fill the major (that is the drained)

empyema cavity with air to make the encapsulation stand out more clearly. It is advisable to take the X-rays from several different angles if the anteroposterior exposures usually taken show nothing.

Once the encapsulation is localized, the method of drainage must depend upon the site of easiest access. Whenever possible it is preferable to drain the encapsulation directly through the chest wall in the same manner that the primary empyema cavity was drained. If the encapsulation is close to the point of original drainage, it can perhaps be opened by passing some blunt curved instrument through the already existing wound. If it is not possible to reach the encapsulation in this manner, the original opening into the chest can be enlarged by removing the rib above and below (the encapsulation usually occurs above the site of original drainage) and inserting the index finger into the chest, breaking up the encapsulation digitally or with a semi-sharp instrument, if necessary under the guidance of a thorascope (I use a regular cystoscope). After the encapsulation has been widely opened the treatment is continued as before.

INTERLOBULAR EMPYEMA

As a rule, an interlobular empyema does not present as difficult a problem as would be expected. As the size of the empyema increases it usually works its way, separating the lobes, toward the parietal pleura and at some part or other can be reached in the same manner as any empyema. Therefore, it is well worth delaying treatment if possible until this occurs.

Occasionally it will be necessary to drain the interlobular collection of pus by means of a two stage open operation, the first operation consisting of opening into the pleura by means of rib resection, examining the lung, and forming artificial adhesions by tape insertion. The second operation, 5 to 7 days later, consists of re-opening the chest wall and establishing drainage through the now firmly adherent pleura. In attempting to locate the empyema, a lateral view roentgenogram is frequently invaluable.

DIFFERENTIAL DIAGNOSIS AND THE TREATMENT OF ACUTE OSTEOMYELITIS OF THE UPPER END OF THE FEMUR, INVOLVING THE HIP JOINT

P. W. NATHAN, M.D., F.A.C.S., New York

LIKE all orthopedic surgeons I have from the beginning of my practice, in the hospital and out, been brought in contact with a considerable number of cases of deformity and disability as the result of acute coxitis. The difficulties that beset the restoration of these patients to even bearable lameness were early impressed upon me; and as opportunities for observing these conditions in the early as well as in the terminal stages of the disease increased, I soon felt the need of a better understanding of the pathology, the diagnosis, and the treatment than could be learned from the textbooks on surgery and the general literature.

With the hope of formulating some more definite signs for differential diagnosis and some more definite indications for the treatment during the early stages of the disease, so that the unsightly and disabling deformities, the long continued suppuration so often met with, and the chronic invalidism so constant a result of these conditions might be at least mitigated, I began, in 1908, the study of these conditions here presented. The subject has been, with interruptions (the cause for which need not be mentioned here), persistently pursued up to the present time.

I have had opportunities during this period for observing over 200 cases. The greatest proportion of these cases was seen in The Mount Sinai and Montefiore Hospitals and in private practice. Some of these cases were seen in consultation and were not under my undivided control; many were seen after they had been treated by general surgeons in this and other cities, but 32 were in my hands from the early to the terminal stages of the disease.

I have, therefore, had the opportunity to compare the results of the treatment of the disease as it is usually carried out in the general surgical services of our large hospitals with those that are obtained, when surgical measures are combined with more or less adequate orthopedic measures. And I have, I think, discovered certain facts regarding the pathology of the conditions which, to a certain extent at least, are qualified to help us in the diagnosis and the treatment of this sometimes so intractable and often fatal disease.

Obviously, it is impossible fully to elucidate the subject within the compass of this paper. Nor do I believe that I have by any means approached the ideal that I hoped to achieve when I set out. But the work has helped me in many ways to a clearer understanding of the subject, and I hope the results of these investigations will be of assistance to others, who like myself, must be responsible for the care of these ofttimes serious conditions.

According to the textbooks on surgery and the monographs that deal with this subject, the final results of the treatment of the more serious forms of acute coxitis leave much to be desired. Those who have seen a great many cases of this disease, and have conscientiously evaluated their results, are most pessimistic in their outlook; and their statistics show a high mortality rate, and a large proportion of the cases with long continued invalidism and permanent functional disability.

The virulence of the disease is held accountable for the large number of deaths. And no doubt an acute osteomyelitis which invades a joint, and which is accompanied by a virulent staphylococcus bacteriæmia is often fatal; and an osteomyelitis that is intense, spreads rapidly, and is attended by profuse suppuration, will result in much tissue destruction, and a more or less complete loss of joint function.

However, when I began to have facilities for studying these cases during the early as well as during the chronic stages of the disease, I soon discovered that although the disease is often a serious one, and difficult to cope with, there was nevertheless a not inconsiderable number in which the virulence of the disease and its destructive action upon the tissues could hardly be held accountable for the permanent deformity and disability that had ensued. I soon found, in a fair percentage of the cases, that with adequate methods of treatment, the more unsightly forms of deformity, and the marked disability so constantly met with, could be mitigated and sometimes altogether avoided. Thus, I have not infrequently encountered cases in which there were high fever, marked constitutional disturbance, sometimes delirium, and an exquisitely tender hip joint, symptoms we have been taught to believe are characteristic of an acute osteitis of the upper end of the femur with extension into the joint, in which I therefore considered the

prognosis as to life or function grave, only to find, that after a more or less stormy course and a protracted convalescence the patient, when certain precautions were taken, recovered without an operation and sometimes with surprisingly little loss of function.

As the number of cases of this character that came to me increased, I began to suspect that there must exist a fundamental difference between these cases and the type of coxitis that almost invariably leads to long continued suppuration, frequent recurrences after the disease has apparently subsided, and which so often terminates in amyloid degeneration of the liver and the spleen, and death.

Formerly the cases that began with or without serious initial symptoms but which recovered without extensive suppuration, were considered synovial in origin, and for this reason the disease was considered less dangerous to life, and less likely to lead to marked destruction of the articulating bones. But even were it true that these conditions are of synovial origin, and that the process sometimes remains localized, leaving the joint cartilage and the bones free, which as will be shown presently rarely if ever happens, this distinction whatever its merits otherwise, is valueless in the present connection.

It goes without saying that in an acute suppurative osteitis an operation is urgently required; often the operation, to be of real service, must be instituted at the earliest possible moment. In the conditions that have been thought to be of synovial origin, on the other hand, an operation is often unnecessary, is on the contrary often actually contra-indicated. Hence the failure to differentiate these two conditions during the early stages, presents a double danger. If one waits until bone necrosis is extensive before an operation is undertaken, not only are the joint tissues irretrievably damaged, but the patient's life is often in jeopardy; if on the contrary one operates before such objective changes are manifest, the patient is subjected to a more or less mutilating operation, which is certain to leave him with a more or less completely disabled hip joint, when conservative measures might have brought about partial or complete restoration of function.

Obviously then, an early diagnosis is essential if these patients are to receive adequate treatment. If the radical difference which obtained in these different types of the disease is due to differences in the origin of the pathological condition, i.e., if the type which originates in the synovial membrane is the milder and is to be treated with conservative measures, and the type which originates in the bones is the more serious and nearly always requires early and more or less radical surgical measures, we must, obviously, have the means by which we can differentiate the two types of the disease during the early stages. None of the authors, however, who classify these conditions as synovial in contrast with primary osteal disease, specify how these morbid processes can be differentiated clinically from each other during the early stages of the disease.

With the advent of radiography it was to be expected that the two conditions could be differentiated from each other by this means. But this hope has proved illusory; for even today with the increasingly great refinements in X-ray technique, it is still impossible to demonstrate bone changes in any form of osteomyelitis during the early stages of the disease. Indeed, such changes only appear in the radiogram when the disease is well advanced, and no earlier in the various forms of primary osteitis than in those in which the bone changes are supposedly due to secondary invasion of the articulating bones as the result of a primary synovial infection. Hence, even were it true that such contrasting conditions actually exist, we have no means of differentiating them at a time when such a differentiation would be of real clinical significance. The constitutional symptoms are similar; the local signs are often indeterminate of one or the other; and the radiograms are often negative or difficult to interpret during the early stages, even in cases that subsequently prove to be typical suppurative osteitides. So, even if this difference in the pathological processes that is supposed to underlie the various forms of acute coxitis were correct, the classification of this disease into synovial and osseous forms is of little help in the clinical differentiation of what are in reality two very dissimilar forms of the disease.

As a matter of fact, it was not long after I began my studies of the pathology and pathogenesis of arthritis in general that I began to doubt that such a distinction really exists. The general aspects of the subject cannot be discussed at the present time; but as concerns acute coxitis, facilities for observing a number of cases throughout the course of the disease, have convinced me that in this condition, at any rate, synovial forms do not occur.

Thus it is thought that the vast majority of the cases of synovial coxitis arise either as complications of general infections, or spontaneously in young children. In my own experience, however, in all the metastatic joint infections, the focus is primarily seated in the bone marrow. In the

milder forms of these affections this is difficult to demonstrate, because the changes are of such a nature that they cannot be shown in the radiogram. But the fact that the specific organisms can be recovered from the bone marrow in all subjects dead of typhoid and pneumonia (Fraenkel and others), whether bone or joint symptoms were present or not during the life of the patient, certainly lends strong support to this view, even though such foci, because of the short duration of the pathological process and the insignificance of the gross changes, cannot be demonstrated clinically. In the cases in which the joint changes and the corresponding symptoms are more marked and of longer duration, the bone changes can sooner or later be demonstrated in the radiogram, or by objective clinical signs.

The coxitis of typhoid fever, for example, was formerly thought to be synovial in character. It was assumed that the profuse exudate which characterizes this condition, leads to such considerable distention of the capsule that the hip is dislocated when the limb is subjected to insignificant trauma. But as was first shown by Graff, and his findings have been confirmed by other competent observers, the pathological process in such cases originates in the acetabulum, where it leads to destruction of the floor and the borders of this structure—changes similar to these found in tuberculosis—(wandering acetabulum), and as a result, luxation of the head of the femur takes place. In typhoid I have found, moreover, the focus to appear primarily not only in the acetabulum, by far the most common seat of the disease, but also in the head of the femur. Figure 1 is the reproduction of a radiogram, showing the changes that ensue in typhoid osteitis, from a case in which the pathological process involved both the femoral head and the acetabulum, that came under observation in the Beth Israel Hospital.

In gonorrhœal infections metastases in the bone are now known to be not at all uncommon. Thus the acute atrophy of the carpal and tarsal bones that is often met with in gonorrhœal arthritis of the wrist and the ankle can hardly be attributed to anything but actual bone infection. I have encountered besides these well known forms of osteitis, osteoarthritis of the knee and the hip joints. In some of the cases of gonorrhœal coxitis, of which the following case is an example, the disease came on suddenly and was attended by such exquisite tenderness in the region of the joint that an examination could not be attempted until the patient was anæsthetized.

Case 1. M. C., a female aged 25 years has been suffering for the past week from exquisite tenderness in the region of the hip joint. She complains of great pain, so much so, that her toilet and the other necessary nursing can be carried out only with great difficulty. It is quite impossible to examine the joints of the limb, because the slightest attempt at moving the limb causes her to scream with pain. She has an acute vaginitis, and smears show the presence of gonococci. The patient was anæsthetized, when the adduction and flexion deformity was corrected, and a plaster spica applied. The bandage was removed 5 weeks later, when the hip was found to be ankylosed, and a radiogram, which owing to the extreme tenderness had not been attempted during the early stage of the disease, showed complete bony synostosis between the head of the femur and the acetabulum (Fig. 2).

Before I had had much experience with these cases, I, as in the case above noted, invariably resorted to immobilization in a plaster-of-Paris spica in the treatment of these cases, and nearly always succeeded in relieving the intense pain so characteristic of this condition—relief that practically always cost the patient the motion in the joint.

It is hardly necessary to describe the conditions as they occur in measles, scarlet fever, and pneumonia. As has already been mentioned, pneumococci and typhoid bacilli are almost invariably recovered from the bone marrow of the epiphyses of the long bones and the spongy bones, particularly from the bodies of the vertebræ in those dead of pneumonia and typhoid fever. It must, therefore, be assumed, that the joint infections in these conditions are secondary to bacterial localization in the bones. Bone foci, moreover, can be demonstrated in practically all the cases with outspoken symptoms, except the cases in which the disease is of short duration, that is, when it is aborted during the early stages.

In measles the joint symptoms are usually mild and transient, so that these need not detain us here. In scarlet fever, however, there is occasionally a pronounced arthritis, the knee being the joint most often involved. Besides a number of cases in the other joints, I have seen 4 cases of acute coxitis, as a complication or sequelæ of this disease. In only 1 of these cases did I see the patient during the early or active stage; in this case the symptoms soon subsided when traction to the limb was applied. The 3 other cases were seen after the acute condition had abated. In these there was deformity and disability, and the radiogram showed the characteristic changes of an osteitis of the femoral head or the neck. All these cases recovered with conservative treatment, and in the days before the use of the radiogram would, no doubt, have been considered as synovial arthritides.

By far the largest number of cases of acute coxitis, that I have met with as complications or

as sequelæ of other diseases, occurred in connection with mastoiditis. Twenty-three cases of this nature came under observation. Eight seen during the active stage were mild and recovered without treatment directed toward the hip joint. Six were seen late, i.e., after the acute symptoms had subsided; of these, 4 had been treated by arthrotomy and 2 by immobilization after repeated joint tappings had failed to reveal pus. In all except 1 of these cases there was dislocation of the femoral head and more or less complete ankylosis with adduction and flexion deformity. The 11 remaining I saw comparatively early in the disease, 8 of them continuing in my care until all symptoms had disappeared. In 6 of these cases, treated according to the method to be described later, there was complete restoration of function. In 2, who still remain under observation, there is still some disability which is apparently gradually diminishing. The interesting feature in these cases is the fact, that in all except the 8 in which the symptoms were transient, the foci and diffuse rarefaction of the head or neck of the femur, or distortion of the acetabulum could be demonstrated in the radiogram, and that in spite of the obvious signs of bone absorption, there was no suppuration.

In by far the largest number of cases of acute coxitis complicating mastoiditis that I have seen, the disease primarily involved the acetabulum, and in the majority of the cases that have come to me, late in the disease, the head of the femur was dislocated upon the dorsum of the ilium, and nearly always firmly ankylosed in this position. There are, of course, milder cases which recover quickly, and without deformity, particularly when precautions are taken to forestall the tendency to displacement or ankylosis. However, although the acetabular form is the most common type of the disease met with in connection with mastoiditis, primary foci in the head or neck of the femur, are occasionally encountered. Such a case, with the result when the disease is treated according to the routine that is apparently established in most of our hospitals, is well illustrated in the following case history.

Case 2. H. E., male 10 years old. Patient had and was operated upon for mastoiditis 10 weeks ago. Although there was not a sinus thrombosis, hæmolytic streptococcus in the blood was repeatedly found. The boy was very ill and ran a spiked temperature for 6 weeks.

He began to complain of pain in the left knee during the third week of his illness, when, on examination, the left hip was found adducted and very sensitive to pressure and passive motion. The joint was aspirated a number of times, but the tap revealed no pus or excess of fluid in the joint. As the joint became more sensitive and the patient complained of great pain, a plaster-of-Paris spica was applied 6 weeks ago. Two weeks ago the spica was removed.

When I saw him on September 10, 1924, the hip joint was apparently firmly ankylosed in flexion and abduction. The radiogram showed osteitis of the upper end of the femur and the acetabulum. From the appearance in the picture (Fig. 3) I was led to believe that the joint cleft still persisted. I, therefore, instituted traction in order to correct the deformity and if possible to restore the mobility by means of passive motion. This proved unsuccessful, and after 3 weeks' trial was abandoned.

Three weeks later he was walking in a brace, but, although he was comfortable, the deformity still persisted. When I saw him last, about 6 months after the illness, he was walking without pain on a flexed adducted hip joint. Correction of the deformity by means of osteotomy was advised, but declined. I am sure that had the traction and passive motion been applied early in the disease, this hip would have been saved.

In the light of my experience with the cases of acute coxitis that came to me as complications or sequelæ of the general infections, I feel justified in assuming that all these conditions are actually metastatic bone infections and that the joint infection is always secondary to a primary lesion in the bone. These conditions are mild and transient, or benign, because the infection is not sufficiently virulent to cause extensive bone changes and actual joint invasion, and not, as most authors formerly believed, because the disease begins primarily in the synovial membrane.

If these forms of the disease, which can be dealt with only summarily here, are excluded from synovial type of the disease, we have only the conditions that occur in young children and infants to consider as remaining in this group. These conditions vary greatly in their virulence and their influence upon the future function of the hip joint. In many of these cases, the disease is mild, transient, and resolves without causing permanent damage to the hip joint. These need not detain us here. In others, the disease takes on the well known characteristics of what is known as infantile ephysitis; and in these there is always more or less destruction of the articular ends of the bone, nearly always suppuration, and occasionally permanent disability. There can hardly be any question, that these conditions are due to metaphyseal infection and, as will be shown later, the primary seat of the disease is in the bone.

If then we must, from our experience of recent years, conclude that all the metastatic forms of acute coxitis are primarily metaphyseal or epiphyseal infections, and this assumption seems eminently justified, we are forced to the conclusion that the more serious forms of what was formerly believed to be a malignant form of synovial coxitis of cryptogenetic origin are also of the same nature.

The writers of the previous decades, designated not only the evanescent forms of hip inflammations of young children, but also the more serious, sometimes even fatal cases of acute coxitis in which pus could not be demonstrated by aspiration or incision, synovial coxitis. In accordance with this view, such cases were usually treated conservatively, and very few surgeons resorted to radical measures in the absence of very definite local signs of abscess or bone necrosis. With the refinements in X-ray technique of recent years, it has become possible to demonstrate that if not in the beginning, sooner or later bone changes are present in practically all these cases, whether there is suppuration or not. It has been found, moreover, that these changes appear equally as early and that they are in many respects quite similar to the changes found, not only during the early, but in the somewhat advanced, cases of true suppurative osteitis of the hip joint. Hence, the view that all the cases of severe acute osteitis are caused by an osteitis or an osteomyelitis, has gradually gained ground; and with this change in our views of these conditions, has come a corresponding change in our attitude toward the treatment of these cases.

With the improvement of hospital facilities and surgical technique, the opening of the hip joint is no longer the dangerous operation that it was in the past; and as the differentiation of the conditions here under discussion has hitherto been difficult during the early stages, the surgeon is urged to explore the joint, if only for diagnostic purposes, in the presence of grave constitutional symptoms even when the local objective signs and the radiogram are indeterminate. It now seems to be the general belief that local signs of hip inflammation with grave constitutional disturbance indicate that there is pus under pressure within the joint structures, and that the tension must be relieved by arthrotomy at the earliest possible moment in order to save life. Indeed, many surgeons not only open the joint at the earliest possible moment but enter the marrow of the femoral head and neck by means of drill holes or by means of a chisel in all cases of acute coxitis that present grave constitutional symptoms, even when there are no definite signs of suppuration.

Long experience has confirmed my belief that this practice avails the patient nothing, whatever the pathological process. In the cases in which there is an actual suppurative process going on in the articulating bones, the operation is merely palliative. In the particular type of the disease I am now discussing, such an operation not infrequently deprives the patient of the chance of at least a fairly good functional result, should he recover from the general infection, and in many cases adds not inconsiderable to the danger of a fatal termination. For while it is undoubtedly true that the older authors were laboring under a misconception, when they spoke of a separate group of acute coxitis as synovial in origin, there are nevertheless good grounds for separating from the well defined pathological and clinical entity designated as acute suppurative coxitis, a certain type of hip inflammation which, despite the similarity of the early symptoms, differs from it in certain very important particulars.

As is well shown in the examples of the conditions I shall now briefly describe, these differences are fundamental, and are not only of theoretical, but of great practical importance. The cases here presented are chosen from a considerable number, because they present the outstanding features of what I hope to show is a specific form of acute coxitis, occurring in both adults and children; and because they illustrate the results which may be attained even in the more serious cases by well directed conservative treatment.

CASE 3. E. W., aged 15 years, was first seen in consultation February 15, 1924. Family and previous history are unimportant. Three weeks ago patient complained of pain in the limbs and headache. That evening she had a chill, and the temperature rose to 104 degrees F. The following day she became somewhat delirious, but when aroused complained of pain in the left lower extremity, which became very acute on attempting to move the limb. According to the family physician, the spleen was enlarged, there were petechiæ present, and there was albumin in urine. On the third day of the illness, when the temperature rose to 105 degrees F. blood cultures were positive for the streptococcus hæmolyticus. A surgeon who was called considered the condition one of osteomyelitis of the upper end of the femur involving the hip joint, and advised immediate operation. When I first saw the child, 3 weeks after the onset, she was much emaciated and cachectic and she had a temperature of 104 degrees F. According to the chart, the temperature was irregular in type with daily remissions of 3 or 4 degrees. The left hip was fixed in flexion and abduction and extremely sensitive to pressure and attempts at passive motion. There was, however, only moderate swelling of the region over the hip joint and on palpation or aspiration there was no evidence of deep suppuration in the joint. For this reason, and because of the patient's condition, I considered it inadvisable to open the joint. The patient was transfused, and the limb placed in traction. An X-ray picture taken on February 23, showed marked rarefaction of the head of the femur, and absorption of the acetabulum (Fig. 4). The patient began to show signs of improvement soon after the transfusion and traction was applied to the limb, but she continued quite ill for several weeks longer. On March 13, the temperature reached only 100 degrees F. The left hip was in good condition; it could be gently moved in all directions without pain. The radiogram showed the previously rarefied bone undergoing condensation.

On April 10, the general condition was good, the affected limb could be moved in all directions without pain, and the patient was up in a wheel chair.

On May 1, patient was up, and was able to walk with the aid of crutches. Radiogram showed the bone practically restored to its normal density.

On June 1, patient was walking in a caliper brace, she was in perfect health, and was able to get around without pain or discomfort. The caliper brace was discarded in August, 1924, and the patient was soon thereafter, able to walk without discomfort, and when examined a few months later walked without pain or limp. She has had no recurrence of the trouble.

CASE 4. F. C., female, aged 14 years. Four weeks ago patient complained of sore throat and headache. Temperature was 102 degrees F. The following day the temperature rose to 104 degrees F. and the child became delirious. The throat was red; the urine negative. The temperature remained high, varying from 103 degrees F. to 105 degrees F. for 8 days, and although the child cried out when she was moved, she continued to be delirious, and no definite objective signs which could be held accountable for the condition could be made out. According to the history sheet the urine examined on the eighth day showed albumin and red blood cells. A blood culture taken at the same time was positive for streptococcus hæmolyticus.

The temperature of a remittent type remained high for several weeks longer; but the delirium gradually subsided, and during the third week of the illness, she had lucid intervals during the day. When awake she complained of intense pain over both hip joints; she cried out in her sleep, and resisted any attempt to move the limbs.

I saw this little girl on August 20, 1919, 5 weeks after the onset of the illness. She was much emaciated, very irritable, and very difficult to examine. Both hips were somewhat flexed, adducted, and apparently immobile. There was some œdema over the hip joints, but I could not make out any signs of deep fluctuation. It was quite impossible, owing to the pain and the resistance of the child, to bring the hips anywhere near the normal position. She was, therefore, anæsthetized, when the hips could be brought down without force, and traction and counter-traction could be applied. During the following week it was necessary to administer codeine and aspirin, in order to keep the child comfortable, but soon thereafter the pain gradually subsided, and about 2 weeks later it was possible to begin very gentle passive motion. A radiogram taken on August 28, showed marked rarefaction of the heads and necks of both femora, infraction of the neck of the left, and coxa vara of the neck of the right femur. It was, therefore, considered advisable to discontinue the passive motion. Nevertheless, the motion in the hip joint remained comparatively free, and an X-ray film taken on September 15, showed the position of the bones unchanged and a considerable increase in the density of the head and neck of the femur.

An X-ray picture taken on October 10, showed marked increase of the density in the bones, but the fracture line on the left side still distinct (Fig. 5). The patient was now quite well and insisted upon moving about in the bed, and was impatient to get up. It was, therefore, with considerable difficulty that we were able to keep her recumbent until the first week in November, when she was fitted with a brace which supported both hips and the pelvis, but permitted flexion and extension of the joints. A month later the patient was walking about with the brace; she had no discomfort, and was permitted to move the hips freely without weight bearing. A radiogram taken at this time showed the bones to be normal in density, and the fracture on the left side to be united. There was coxa vara on both sides. At Christmas the child walked well without noticeable limp, and had apparently completely recovered. She remained well until February, 1920, when she had an attack of appendicitis and died after the operation.

CASE 5. J. G., aged 30 years, was admitted to the medical service of Mt. Sinai Hospital, October 3, 1923. Six weeks ago patient had a slight infection of the lip, for which she applied home remedies. The swelling nevertheless increased and extended to the cheek and closed the right eye. In about a week the swelling and the pain somewhat subsided, but toward the end of the second week the patient had a chill, which was followed by fever and delirium. The condition in the lip and face slowly subsided and was apparently completely healed 4 weeks after the onset. The fever and delirium lasted 3 weeks. When consciousness was completely restored, she found that she was unable to move the right lower extremity, and the most gentle attempts at motion caused the patient excruciating pain.

Status on admission: Patient was an emaciated woman, who lay immobile in bed, and cried out when she was moved. Her temperature was 101.4 degrees F. The internal organs, the urine, and blood (with exception of a secondary anæmia) presented no pathological changes. There was tenderness over the right thigh and hip joint, most marked over the great trochanter. There was a pressure sore upon the right heel, and decubitus covering an area of about 4 inches in diameter over sacrum. Radiogram of the hip joint showed an erosion of the head of the femur and the opposing surface of the acetabulum.

Patient was transferred to the orthopedic service of the hospital on October 10, 1923. She resisted any effort to move the right lower extremity, but by exercising great care in the examination, it was possible to elicit some motion in the joint; but motion was so painful that a complete examination was impossible. Although the soft parts over and surrounding the hip joint were somewhat œdematous, there was apparently no considerable effusion in the joint interior. Temperature, which had been remittent in type, was today 102 degrees F. Radiogram showed an extension of the process previously reported.

Owing to the presence of the decubitus, the patient was placed on the abdomen, and traction was applied in this position. On October 17, the patient was much more comfortable, and it was possible to move the hip joint without causing nearly so much distress. Temperature did not rise above 100 degrees F. She did not object to the prone position.

From this time onward, the condition gradually improved. The temperature did not rise above the normal after 2 weeks, and the calcaneal, and the sacral decubitus gradually healed. Passive motion in the affected joint became less and less painful, and with persistent but gentle passive motion and continuous traction, the motion increased until it approached the normal in about 8 weeks after admittance. The clinical signs of improvement were accompanied by corresponding changes in the appearance of the articulating bones in the radiogram. Thus, on November 12, 1923, the report from the laboratory reads: Examination of the right hip joint shows a destructive bone disease of the head of the femur as well as of the acetabulum. The appearance is that of an osteomyelitis. The osteomyelitic process is more advanced than at the last examination. On January 23, it was reported that there was a marked improvement as compared with the last examination. There appeared to be some reconstruction of the previously decalcified areas in the bone.

The patient's condition continued to improve; the motion in the hip became painless, and on April 2, when she was discharged from the hospital, the motion in the joint was quite free in all directions, and she was able to

walk short distances without assistance and without discomfort. The X-ray appearance on discharge is illustrated in Figure 5.

When she was examined 1 year later, the motion in the hip joint was found to be only slightly restricted. She walked well without limp, and carried on all her household duties without discomfort. In 1926 she was delivered of a normal infant after an uneventful pregnancy.

CASE 6. A. K., aged 32 years, was admitted to the medical service of Mt. Sinai Hospital, October 24, 1922, with the following history: Two weeks ago she had an attack of tonsillitis, frontal headache, and difficulty in breathing. For relief of the last she submitted to an operation upon the interior of the nose. On the following day she had fever, and complained of pain in the knee. The fever had continued, and the pain in the knee had gradually become more and more intense.

On admittance to the hospital the temperature was 102.4 degrees F. The heart and lungs were negative, and the spleen was not palpable. The left knee was somewhat swollen and tender to pressure. There was also tenderness to pressure over the lower end of the humerus and the upper end of left tibia. The radiogram showed no pathological change in the knee or the bones of the leg. The patient continued to run a remittent fever, the temperature occasionally reaching 105 degrees F. The chief complaint was pain in the areas mentioned.

I first saw the patient on November 12. Her temperature on that day rose to 105 degrees F. I found the knee somewhat swollen but not particularly tender. There was marked restriction of both voluntary and passive motion of the hip joint but in the somewhat obese woman it was not possible to make out swelling over the hip joint. On aspiration of the joint only a small amount of clear fluid could be obtained. The patient complained bitterly of pain in the knee. Diagnosis: acute septic arthritis of the hip joint. Treatment: traction. Traction was applied November 24.

Pain in the knee subsided soon after the traction was applied and a week later passive motion in the hip caused little discomfort. On December 9, it was noted that patient had an attack of furunculosis. On the 21st, an abscess in the left lumbar region was discovered. This was opened and drained, and discharged thin pus for about a week, when the wound was permitted to close. Early in January another abscess appeared on the external aspect of the thigh, about 7 inches below the trochanter. This increased in size, and was incised on February 1, 1924. The wound discharged rather profusely for about a week; the discharge began to diminish and ceased entirely at end of second week, and the wound closed soon afterward. The abscess cavity did not communicate with the hip joint.

Examination on February 1, showed the hip to be quite firmly synostosed. Radiogram taken a few days previously showed an erosion of the head of the femur, and an erosion of the corresponding surface of the acetabulum.

The patient continued to run a remittent fever until the end of February, when the temperature came down to normal, and remained so until she was discharged.

A hip splint was applied on May 12, and with this support she was soon able to walk about the ward. She wore the brace for about a month; it was then discarded and she was able to be about the ward and could walk well without much limp.

She was discharged from the hospital on June 6, 1924. She had regained her health and strength. She had ankylosis of the hip joint in good position, but walked without support and without discomfort (Fig. 7).

Re-examination was made January 3, 1929. The patient walked well without support but with a slight limp. She has had no trouble from the hip since her discharge from the hospital. The hip joint was fixed in good position.

CASE 7. M. A. was admitted to the medical service of the Mt. Sinai Hospital, December 9, 1923, with the diagnosis of postpartum sepsis and arthritis of the right knee. Three months ago patient was delivered of a full term infant. Three days after delivery she had fever and complained of pain in both feet. The pain in the left foot soon subsided but persisted in the right throughout the following month, when the entire right extremity became œdematous and sensitive, particularly so over the knee joint. Temperature record not obtainable.

Examination on admittance showed the right knee to be much swollen and very sensitive to pressure and passive motion. The patient cried out when the knee was flexed and complained of intense pain in and near the joint even when at rest. The limb was adducted and rotated out which strongly suggested a pathological condition in the hip joint but patient resisted examination so that the actual condition could not be determined.

The radiogram disclosed an arthritis of the knee and arthritis of the hip with dislocation of the head of the femur on the dorsum of the ilium (Fig. 8). The patient was transferred to the orthopedic service. Traction was applied in an endeavor to bring down the head of the femur. As this proved unavailing the patient was anæsthetized and an attempt was made to reduce the head of the femur by manipulation. This also proved unsuccessful.

On January 9, the hip joint was opened by means of an Ollier incision; the trochanter with its attached muscles was freed and reflected upward, and the hip was readily reduced by manipulation. Figure 9 is the radiogram after operation, showing the head in the socket.

The plaster spica was removed February 3, and the patient was discharged from the hospital March 8, 1924, with the femoral head in good position and the motions in the joint quite free and painless. The knee joint was still somewhat swollen and the motion was restricted.

The patient was readmitted to the hospital on May 27, because of pain and stiffness in the knee joint. The motion in the hip joint was free but the trochanter was high and radiogram showed recurrence of the dislocation. Traction and passive motion were instituted in the hope of recovering the motion in the knee joint. This proved unsuccessful and the patient was discharged from the hospital, with the knee ankylosed at an angle of 170 degrees. She was, however, now free from pain, the motion in the hip joint was free and painless, and the general health was excellent. She had 3 inches' shortening, and walks with a considerable limp.

In the light of the generally accepted teaching the cases here described would, had the local condition been recognized during early stages of the disease, have been regarded as cases of acute osteomyelitis of the upper end of the femur with involvement of the hip joint. They would, therefore, for the most part, have been subjected to some form of active surgical procedure. And if one evaluates the general and local symptoms, and the local signs as shown in the radiogram, such treatment, if the accepted teaching is correct, would be eminently justified.

For in these cases we have the usual serious constitutional disturbance, the local objective signs of an acute osteitis, or osteomyelitis, involv-

ing the hip joint. The radiograms, moreover, show the pathological changes that are usually considered to be characteristic of this condition. Thus, Case 3 shows the extensive and intensive rarefaction of the bones of the femur and acetabulum; Case 4, coxa vara and infraction of the neck of the femur; Cases 5 and 6, the circumscribed lesions; and in Case 7, the radiogram shows the complete dislocation of the head of the femur on the dorsum of the ilium; lesions which are considered characteristic of the various types of acute suppurative osteomyelitis of the upper end of the femur involving the hip joint.

But, despite the parallelism of the general symptoms and the objective changes, these cases present nevertheless a very important feature, which must inevitably distinguish them from the cases of true suppurative osteomyelitis which involves or is likely to involve the joint.

This distinction lies in the fact that in the condition from which these patients suffered, the patient recovers from the disease without operative interference. Not only does he recover from the initial infection, but in striking contrast to the final outcome so inherent in the true forms of suppurative osteomyelitis of the upper end of the femur, the patient remains free from chronic suppuration and never suffers from the recurrences and metastases which are, in my experience, inevitable in the latter condition when treated by conservatory surgical measures. In the case histories which here follow, this contrast is well exemplified.

Case 8. M. D. I first saw this patient in private practice in 1912, when she was 10 years old. She came to me for a painful adducted left hip with a secreting sinus in the groin and another in the gluteal region. She was said to have had an osteomyelitis of the upper end of the femur about a year before, which had been treated by operation. The head of the femur was said to have been removed. I opened the hip joint for the removal of a sequestrum. On coming down upon the bone (Langenbeck incision), I found that there still remained a portion of the head *in situ* firmly synostosed with the upper border of the acetabulum. The sequestrum was removed, the deformity corrected, and the limb was immobilized in a plaster-of-Paris spica. The sinus remained open, and discharged for several months after the operation, but finally closed, and the recovery was otherwise uneventful.

The sinus remained healed for about 6 months, and then re-opened, discharging for 3 weeks. After this, although the sinus in the buttock remained closed, the one in the groin had re-opened on an average of about once a year until 1916.

She came to me on May 1, 1917, complaining of pain in the middle of the right arm. On examination I found a hard swelling over the middle third of the humerus which, in the X-ray picture, proved to be a bone abscess. This was opened and drained for about 4 weeks, when the wound was permitted to close. She had no further trouble with the arm. But during the following 7 years, the sinus in the groin repeatedly opened and discharged pus, until finally it remained patent throughout the year of 1924. In 1925, her general health was poor. I, therefore, advised her to have the hip resected but this was refused. She was then advised to go either to Switzerland or to southern California. She went to California where she remained until 1928. When I saw her again, she gave a history of having had another focus in the upper end of the left humerus which had been opened, and which now gave her no further trouble. The sinus in the groin, however, was again discharging and the right hip was painful. Resection of the hip was again advised, but declined. The duration of the illness was 18 years.

Case 9. J. O., male, aged 9 years, was admitted to the Mt. Sinai Hospital, June 27, 1926. Patient had a sore throat 3 weeks ago. A few days ago, after an insignificant trauma, he complained of pain in the left lower extremity; his temperature rose, and he appeared to be profoundly ill. His temperature was 104 degrees F.

The very sick child cried out when examination was attempted. The internal organs showed no abnormality. The left hip was swollen, exquisitely tender, and both voluntary and passive motion was restricted. Blood cultures were positive for staphylococcus aureus, 30 colonies to the cubic centimeter. The hip joint was incised when a large amount of pus was evacuated. The condition remained unimproved during the next few days. Blood cultures were still positive, and the micro-organism was also cultured from the urine.

On July 1, the temperature was 104 degrees F. The wound was re opened and drill holes were made through the trochanter into the neck of the femur. The temperature remained high after the operation. July 7, blood culture showed staphylococcus, 15 colonies to the cubic centimeter. Blood culture on July 8 was sterile. A week later there were swelling and pain in the right shoulder; this subsided spontaneously within a few days. Repeated X-ray examinations showed an osteomyelitis of the upper end of the femur and of the ilium. On August 17, roentgen examination of the left hip and thigh showed an osteomyelitis extending from the head of the femur to the shaft below the trochanter. The upper two-thirds of the shaft had become a sequestrum much surrounded by involucrum.

On August 11, a sequestrum was said to have been removed. Radiographic examination on September 2, showed an osteomyelitis of the left femur involving practically the entire shaft, the original bone forming one large sequestrum surrounded by an involucrum at least one-half inch in thickness. The head of the femur seemed to be intact but separated from the neck of the bone; and there appeared to be some productive changes about the hip joint apparently extending from the upper lip of the acetabulum to the femur.

He was discharged from the hospital on October 26, with a temperature of 100 degrees F., and the hip still draining. He was to be dressed at home. He was readmitted to the hospital December 28. One week ago an inguinal abscess opened spontaneously. He was said to have had a temperature of 103 degrees F. The old wound on the external aspect of the thigh was still draining. Treatment consisted of rest in bed and dressings. The temperature soon came down to normal and he was discharged from the hospital February 14, 1927. The wound was still draining.

Patient was readmitted to the hospital July 26, 1927. He remained in bed for several months after he was last discharged from the hospital. He then was able to be about with brace and crutches. He felt fairly well until 3 months ago, when he began to have recurrent pain in his left elbow which lasted for from a few hours to several days. Temperature was 100 degrees F. The arm was swollen and hot and the pain kept him awake at night.

The left elbow was flexed and permitted of only a few degrees of motion. There was also tenderness and pain on deep pressure over the right elbow, most marked in the cubital crease. On July 1, 1927, a sequestrotomy was done for chronic osteomyelitis of the femur. Incision was made on the lateral aspect of the thigh down to the bone; the entire head of the femur was found to be loose and was removed. Two or three more sequestra from the shaft of the femur were also removed. Mikulicz tampon was used. On July 11, a secondary suture of the wound was done. The sinus over the femur continued to drain when he was discharged from the hospital on September 17, 1927.

Patient was readmitted to the hospital on August 7, 1930. Since last admittance he has been about most of the time. He has had, besides the disability from the hip joint, which was fixed in flexion and adduction, four or five attacks of pain and swelling in the right elbow. During the intermissions the elbow could be used without much trouble. There was marked swelling and restriction of motion in the right elbow. It was held in semi-flexion; pronation was not affected; supination was somewhat limited and painful. The right hip also gave him some pain.

Radiogram showed marked atrophy of the bones of the forearm; there were proliferative changes in the olecranon and marked soft tissue swelling. The left elbow showed the changes of an old infective process. After a short stay in the hospital, he was again discharged as improved. The duration of the illness was 4 years. The condition was still active.

CASE 10. J. F., male, aged 16 years, was admitted to the Montefiore Hospital, March 14, 1924. One year ago he fell and was said to have injured the left leg. One week later he had fever. Three weeks later he was admitted to a Brooklyn hospital, where an abscess of the left hip was incised and a plaster-of-Paris spica was applied. He remained in the hospital for 6 months and was discharged with a stiff hip and a draining sinus. He had lost 30 pounds.

Condition on admittance to the Montefiore Hospital: Patient was an emaciated cachectic boy, with no abnormalities of the internal organs. The motion in the left hip was partially restricted and there was a discharging sinus in the left buttock. The extension of the knee was limited and there was an old healed sinus under the patella. The ankle and the foot were somewhat swollen and the motion in the joint was restricted. The radiogram showed partial destruction of the head of the femur and the acetabulum; partial ankylosis of the hip joint with fairly extensive bone production of the upper two-thirds of the acetabulum which extended into the pelvis. On June 25, an abscess of the left ankle and the foot opened spontaneously. The gluteal abscess was practically healed.

During the early part of July, an abscess appeared over the left humerus. This soon opened spontaneously and the wound healed during the early part of August, but soon re-opened again. He was discharged from the hospital on November 26, 1925, at his request, as improved, although the sinuses were still draining.

He returned to the hospital February 2, 1926, because the sinuses were discharging profusely. The sinuses continued to drain off and on, and were still draining on September 20, 1927, when a bone abscess in the upper end of the right tibia began to cause him much pain. The abscess was incised and evacuated. With exposure to the sun his general condition improved but he was still very thin and pale.

The left hip was enclosed in a plaster spica and he was able to be about. The hip was no longer painful and the gluteal abscess was closed. On June 15, 1928, it was noted that the hip was ankylosed in flexion and adduction. The radiogram remained unchanged. The left knee was painful and permitted of only 45 degrees of motion. The left extremity was 1½ inches shorter than the right. The deformity in the left hip was corrected by subtrochanteric osteotomy. He was discharged from the hospital September 29, 1928.

He was readmitted November 26, 1928. While at home the abscess of the left hip re-opened and another appeared in the left ankle. The abscess of the hip healed spontaneously, but that in the ankle was still draining. He was admitted to the hospital with the diagnosis of old chronic osteomyelitis of the left hip and ankle with metastasis in the right hip and bone abscess in the right tibia. Both hips were incised for drainage. He was still in the hospital in January, 1931, with the condition varying, but showing no signs of permanent resolution. As shown in the reproduction of the X-ray film taken November 30, 1930, there still remained an active process in the upper end of the femur and the acetabulum. The duration of the illness was 8 years.

The cases here presented are not isolated or exceptional instances of this morbid process; they are simply examples of the results of more or less conservative surgical treatment that I meet with continually in private and hospital practice. It should be noted that the results obtained are inadequate, not only in the cases that present alarming symptoms from the beginning and in which suppuration is profuse and continuous, but it also prevails in the cases, as for example in Case 8, in which the acute symptoms have subsided and suppuration has apparently ceased.

The difference in the cause and the end-results in these two types of acute coxitis, as exemplified by the two groups of cases here presented, is most striking. In the one, the first group, the disease, no matter how acute the onset or how serious its aspect during the early stages; no matter how extensive the bone involvement as shown in the radiogram, the patient, except in the very virulent forms of sepsis, which ends fatally during the acute stage, finally recovers completely. There may remain deformity or ankylosis, although these may be mitigated or completely avoided when proper remedial measures are employed, but there are rarely, if ever, recurrences. When, as very rarely happens, there is an abscess, this clears up with simple incision. There is never chronic suppuration, secreting sinuses, or secondary foci, and the disease never terminates in amyloidosis.

In the second group the disease, when treated conservatively, that is, by simple incision and drainage with or without palliative operations on the articulating bones, always tends to become chronic after the subsidence of the acute stage. There is always an abscess, and the sinuses that arise therefrom are likely to remain patent for a long time; and when they finally close, are always

likely to re-open after a longer or shorter interval and again secrete pus and discharge bony sequestra.

There is always sequestration. The sequestra may be massive or they may be small; they may remain *in situ* for many years slowly disintegrating, or small particles from the free sequestrum are more or less constantly being discharged from the sinuses that remain permanently open or reappear as the diseased bone is forced to the surface of the limb. Recurrences in cases apparently healed many years before or acute exacerbations in chronic cases almost always supervene and secondary foci in the other bones or elsewhere are often met with both early and late in the disease. Finally, a considerable number of the cases, to judge from my experience in private practice and in the Montefiore Hospital, eventually succumb to suppuration in vital organs or amyloidosis, the result of years of more or less continuous suppuration.

As soon as I began to appreciate the dissimilarities that exist in the two forms of what I had been led to believe to be a single entity, I began to treat the cases, not by radical surgery during the acute stage as my early training had influenced me to do, but by conservative measures, that is, by mechanical or conservative procedures. As my experience became more extensive and I began to have the facilities of following the cases more closely over long periods, delaying operative interference as long as possible in the absence of demonstrable suppurative osteitis, when I could do so without seriously endangering the patient's life, the view that such contrasting forms of osteitis actually exist became more and more convincing.

Nevertheless, the period during which I awaited the appearance of definite differential signs was always fraught with considerable anxiety to the patient's relatives and to myself. For this reason if for no other, the want of a method by which these two, as I felt convinced, very distinct morbid processes could be distinguished from each other during the early stages became more and more insistent. I tried various methods, the nature of which need not detain us, to overcome this difficulty without success until at last I tried, what according to the generally accepted teaching appeared to be the least hopeful, to segregate the cases according to the type of the invading micro-organism.

Hitherto, it had been generally assumed that acute coxitis or osteitis was caused by a number of different organisms, the staphylococcus, the streptococcus, and the pneumococcus being considered the most common causative agent. It was thought that all these organisms were capable of causing an acute or chronic suppurative osteitis of the hip or any other joints. Of these the staphylococcus was considered the most frequent cause of the disease, but the streptococcus and the pneumococcus were thought to be equally capable of causing a morbid process that differed in nowise from the condition caused by staphylococcus aureus. That this view was not absolutely true first suggested itself to me when I began to see a considerable number of cases of osteitis as complication or sequela of mastoiditis. In these as is generally known, the hæmolytic streptococcus is quite the most common invader; and, as in these cases prolonged suppuration of the joints, rarely if ever, supervened, the possibility suggested itself that the differences that prevail in the two types of acute coxitis might be due to the differences in the pathological changes that are caused by the activities of these invading micro-organisms.

As my facilities for bacteriological examination increased I began to segregate the cases that came to me during the early stages according to the organism found in the blood or in the joint exudate. Thus, all cases that showed streptococci in culture or were doubtful, were treated by conservative or rather by mechanical means. I soon found that this method of segregating the cases was of eminent practical value. For, guided by this method of segregating the cases, I found myself in a position, in by far the largest proportion of the cases, to determine from the beginning just which cases would eventually require surgical intervention, and which cases could be effectually treated by conservative or mechanical means.

I could be certain that a patient with an acute streptococcus coxitis would rarely if ever require an operation and that, with the exception of the most virulent forms of streptococcus septicæmia, a patient with this form of coxitis would, with proper management recover without suppuration or recurrences, sometimes with fairly good motion in the joint, or at least, the joint firmly ankylosed in good position for function. As my material became more and more abundant, the evidence in favor of this method of grouping the cases and its clinical implications grew so convincing that I no longer hesitated to treat, as shown in the first group of cases recorded above, all cases of acute coxitis upon this basis no matter how threatening the general constitutional disturbance.

I found, of course, that a streptococcus infection with a focus in the hip joint or elsewhere may be very virulent and sometimes end fatally. But

in many of the cases, in by far the greater number, I found that the disease after a more or less stormy course would finally subside, perhaps leaving the patient with a stiff hip, but free from the danger of a recurrence and otherwise quite restored in health. In my experience streptococcus infection of the hip or other joints rarely if ever leads to long continued suppuration, certainly the seropurulent exudate either within the capsule or the periarticular structures sometimes encountered in these conditions is, as far as its tendency to become chronic, or its destructive action upon the bone and the soft tissues is concerned, in nowise comparable to the purulent exudate that is so characteristic of staphylococcus infections.

Thus only under exceptional circumstances have I been compelled to open and drain an abscess leading to the hip joint. Never since I have learned to recognize the morbid condition have I felt the necessity of performing sequestrotomy or resection, and rarely have I been compelled to deal with the seriously disabling conditions of the hip joint which are generally considered so inevitable after all forms of osteomyelitis of the hip joint.

In the majority of the cases of streptococcus coxitis that have come to me late, arthrotomy had been performed. In some of these more or less profuse suppuration is said to have existed but in none of these had the suppuration been long continued. However, whether suppuration was present or not, whether the patient had been operated or not, hardly a patient that came to me late was free from some more or less permanent functional disability of the hip joint. In the majority of the cases the head of the femur was deformed or dislocated upon the ilium and the motion was largely or wholly restricted. Practically all such cases were considered to be and treated as cases of acute osteomyelitis of the upper end of the femur.

The final result in these cases is common knowledge. At any rate, the deformity and disability of the hip joint is well described in the textbooks, and the periodic literature. It is, therefore, unnecessary to report a large number of cases in order to demonstrate these facts. The following case histories which bring out the course of the disease and the results of treatment as usually carried out, must suffice to exemplify the points I wish to make clear.

CASE 11. G. K., aged 12 years, was admitted to the surgical service of hospital, September 8, 1925, with the following history. Three weeks ago, without previous illness or trauma, patient suddenly developed pain in the region of the knee joint. A week later he complained of pain in the left hip joint. He is said to have had a high fever at this time and was treated by rest in bed. The fever with recurrent chills continued for 2 weeks, when a second physician was called. He considered the case one of osteomyelitis of the upper end of the femur and referred the patient to the hospital.

On admittance the patient appeared very ill but there were no objective signs except the local condition. Locally there was marked tenderness over the entire circumference of the upper third of the thigh extending upward to the left iliac region. Marked impairment of the motion in the left knee and the left hip was noticeable.

On September 8, 1925 (the day of admittance), the patient was subjected to operation. A vertical incision over the great trochanter through which an abscess cavity entered and a counter incision 3 inches posteriorly were made. Opening was made in the great trochanter and the diseased bone was chiseled away. No pus was found in the medullary cavity. The wound was packed.

Blood cultures taken on September 8 and 11 were positive for the hæmolytic streptococcus; the bacteriology of the wound was not recorded. The temperature fell somewhat after the operation, but it rose again on the third day and he then ran a septic temperature with a daily rise to 104 degrees F. for 2½ weeks, when with occasional elevations it gradually fell to normal after 11 weeks.

On September 25, traction was applied; and on October 14, the limb was fixed in a plaster-of-Paris spica. He was discharged from the hospital and referred to the orthopedic clinic on January 8, 1926. A radiogram taken September 11, 1925, showed rarefaction of the upper end of the femur. On September 23, the report from the radiogram read negative except for the operative procedure. On December 1, it was reported that there was an osteomyelitis of the upper end of the femur which was dislocated upon the ilium.

In the outdoor department of the orthopedic service the patient continued wearing a spica for about 3 months. The latter was then discarded and he was given a high shoe. He reported at irregular intervals and at his last visit, January 21, 1929, the hip was found to be ankylosed in flexion and adduction. There was 3 inches of practical shortening; there had been no recurrences and, although he limped, he had no difficulty in walking. The radiogram of the condition in the hip at that time is reproduced in Figure 11.

Here we have a child with a history of pain in the knee and then in the hip joint accompanied by definite signs of sepsis extending over a period of 3 weeks. He was brought to the hospital with a diagnosis of osteomyelitis of the upper end of the femur, and although the radiogram was reported as negative, he was immediately subjected to operation. An abscess cavity was said to have been entered, but the operation sheet states that no pus was found in the spongiosa of the neck of the femur. Counter drainage was secured by a posterior incision. However, although the temperature fell somewhat after the operation, it soon rose to 104 degrees F. and running a high septic course for several weeks, gradually subsided to become normal 7 weeks after the illness began. The bacteriology of the wound was not recorded, but blood cultures were positive for hæmolytic streptococcus on two occasions.

Although it was noted that an abscess cavity was entered at the time of operation, no mention is made of the presence of pus in the joint and it is stated that no pus was found upon drilling into the spongiosa of the neck of the femur. This is, of course, not surprising in this case when the radiograms are examined. The reports read: September 11, 1925, rarefaction of the upper end of the femur. September 23, negative except for the operative procedure. December, osteomyelitis of the upper end of the femur which is dislocated upward on the ilium. My examination of the X-ray pictures convinced me that the changes in the upper end of the femur were, for the most part if not entirely, caused by operative procedure. At any rate the fact that the dislocation ensued is good evidence that the acetabulum was involved and was in all probability the main seat of the disease. Hence, even were this a case of staphylomycosis, the procedure here adopted would have been unavailing. In the present instance having to deal with a case of streptomycosis, involving for the most part the acetabulum, the procedure was entirely ineffectual. The precautions that are necessary to maintain the femoral head in its proper relation with the acetabulum were neglected during the early stages of the disease, with the result that although 4 years have elapsed without a recurrence and without a sinus, the child is left, as is shown in Figure 11, with the femoral head dislocated and ankylosed upon the dorsum of the ilium. He has a flexed and adducted hip, no motion, considerable shortening, and will have permanent disability.

The course of the disease and the terminal conditions which ensue when these patients are treated according to the methods customary in many of our large hospitals at the present time, are still more graphically illustrated in the following case.

Case 12. R. B., aged 5 years and 11 months. Two weeks ago he had an abscess of the mouth (?) for which two teeth were extracted. Five days later he vomited, complained of pain in the abdomen, and had a high fever. On the second day of the illness he complained of pain in the left lower extremity. He had had several chills the night before he entered the hospital. He was admitted to the private pavilion of the Mt. Sinai Hospital on December 23, 1928. His temperature on admittance was 102 degrees F. He was irritable and cried out when moved in bed, and complained of pain in the left hip. The internal organs appeared normal. The hip was not swollen. Blood culture was positive for streptococcus hæmolyticus. A radiogram taken December 27, 1928, failed to show any abnormality in the pelvis or the hip joint. Diagnosis: sepsis with osteomyelitis of the upper end of the left femur. Operation consisted in an osteotomy of the left femur for osteomyelitis. The operative diagnosis was osteomyelitis of the upper end of the left femur. Pus was obtained on incision and roughened bone was found at the depth of the incised area.

As the child continued to run a high temperature, the hip was again explored on January 12, 1929. Exudate from the joint and the marrow cavity examined bacteriologically was found to contain streptococcus hæmolyticus in pure culture. The child was placed in an overhead traction, both hips being held at right angles.

An X-ray picture taken January 24, 1929, showed a complete dislocation of the left hip, the hip riding high above the acetabulum. There was evidence of a bone defect on the superior aspect of the great trochanter and the neck of the femur, probably due to an operation (Fig. 13).

The patient continued to run a septic temperature, but seemed somewhat more comfortable after traction was applied. The radiogram taken March 11 (Fig. 14) showed that there was considerably more absorption in the region of the head and neck which was operated upon; and there was in addition some bone proliferation on the mesial aspect of the neck of the bone. The right hip previously reported normal, showed an upward dislocation of the head of the femur.

I saw the child on March 20, and as the temperature had been down to almost normal for several weeks, I advised that an attempt be made to reduce the dislocation by gentle manipulation, and if this proved successful, to maintain the reduction by traction and counter traction with the hips in extension. When I saw the child again, early in April, I found the hips still dislocated. The temperature rose immediately after the manipulation, and had remained high since then. The right hip was now tender and there was an œdematous swelling over the joint which extended over to the dorsum of the ilium where there appeared to be some fluctuation. The patient was transferred to my service in the Mt. Sinai Hospital.

During the next week, the swelling over the hip joint became more marked, the pain in this region became more intense, and the temperature reached 104 degrees F. On April 10, 1929, I incised the fluctuating mass over the hip joint. I entered a well defined abscess cavity which apparently did not communicate with the hip joint. The contents of the abscess were typical of an infected hæmatoma which, I thought, resulted from the manipulations employed in the effort to reduce the dislocation of the hip. The abscess was treated by through-and-through drainage.

The fever gradually subsided, the drains were removed 2 weeks after the operation, and the wound closed promptly. The child was sent home to convalesce on May 4. At this time he had little fever, and there was no pain when the extremities were held in traction. The hips were fixed in flexion and adduction.

At home the wound from the last operation soon closed, and the general nutrition improved immensely. When I saw the child again during the middle of June he was comfortable; his temperature had been normal for some weeks, and he was able to move about the bed without pain. The hips were still fixed in the deformed position. He continued to improve during the summer months, so much so, that he was out of bed walking in a support in September. He was again radiographed December 5, 1929 (Fig. 15). There was found some restoration of the density of the bones, but the hips were firmly synostosed above the acetabulum. When I saw him a few weeks ago, he was walking without support; he had no pain; and there were no signs of abscess. The gait was characteristic of that which usually ensues when the hips are dislocated and synostosed on the dorsum of the ilium.

This case well illustrates a number of the important features of streptococcus coxitis. The early symptoms are typical of sepsis and are apparently not unlike those that are characteristic of a staphylococcus infection of the hip joint or an osteomyelitis. The hip is acutely inflamed and exquisitely tender, but the radiogram shows no definite abnormality. The hip is incised and an osseous focus is searched for without result by means of drill holes. The exquisite tenderness is relieved by traction. In this case, however, the traction applied with the hips flexed and adducted certainly aggravated the tendency to dislocation that always exists in these cases.

The disease in the right hip was entirely unsuspected during the early stage of the disease and its presence was revealed only when the hip was radiographed after dislocation had taken place. Thus the acute inflammatory process in the bone had run its course without suppuration and without recourse to the more or less radical surgical operation that is so generally considered necessary in these conditions. It would, moreover, have run its course without dislocation had the traction been properly applied.

It is hardly necessary to multiply the examples of the disease to show that streptococcus infection of the hip joint, and as I hope sometime to show of other joints, is a condition that differs radically from the staphylococcus infections. The typical examples in both adults and in children here recorded must, I believe, inevitably lead us to conclude that the two conditions are essentially different, not only as to the cause, but in the morbid process in the tissues, the course of the disease, and the final outcome.

Patients with streptococcus infection of the hip and elsewhere, with certain exceptions which cannot be dealt with here, either die during the acute stage of the disease or, after a more or less prolonged and often very serious illness, recover completely. When the hip joint is seriously involved, and the precautions to prevent deformity and dislocation are neglected, permanent disability is almost sure to ensue, but there is never long continued suppuration or recurrences. With proper management a fairly good permanent result is obtained even in the most serious cases, and in the moderately severe type of the disease the patient will recover without loss of function.

In the staphylococcus infections, on the other hand, complete recovery rarely if ever occurs with conservative treatment. Not even the more or less conservative operative measures, such as incision and drainage or the drilling of the spongiosa so generally adopted, are availing. These measures are merely palliative; the patients are, it is true, often discharged from the hospital apparently relieved, but I am constantly meeting such patients both in private and hospital practice, who have secreting sinuses of long standing, with recurrences, and secondary foci in other bones. I find, moreover, that many of the patients who have been discharged from hospitals apparently cured finally succumb after years of recurrent or continuous suppuration to amyloidosis.

The examples of staphylococcus coxitis I have here recorded are not picked cases, they represent the average run of cases that come to me in both hospital and private practice. They show most clearly that even in the apparently more favorable cases, the results obtained by more or less conservative treatment are, to say the least, inadequate. Very often the patients suffer not only from the sinuses and the general debility of the chronic diseases but by far the majority of them are, even during the periods of quiescence, more or less completely incapacitated by the deformity, the shortening, and the pain in the hip.

A great proportion of these patients, in my experience at any rate, finally succumb. This is true of not only the cases in which the disease in the bone is extensive from the beginning, but it is also true of the cases in which the disease according to the radiographic findings remains, for a time at least, circumscribed. This is well shown by the two cases which are simply examples of the many that are constantly coming to the Montefiore Hospital, which here follow.

CASE 13. P. W., aged 16 years, was admitted to the Mt. Sinai Hospital, February 10, 1925. About 3 months previously patient is said to have had a crop of furuncles on various parts of the body. About 4 weeks ago he fell and sustained a slight contusion of his right elbow. A day later he complained of severe pain in the region of the right hip, and soon after he had fever and was unable to walk. Since then he has remained in bed suffering acute pain, with temperature fluctuating between 101 and 105 degrees F.

Physical examination disclosed a pale, emaciated boy, apparently seriously ill. The internal organs showed no abnormality; patient cried when touched. The right hip was extended and adducted and patient screamed when any attempt was made to move the hip joint. Posterior to the great trochanter there was a clean, granulating wound about 5 inches in length. The latter was caused by an exploratory operation on the hip joint undertaken in another hospital. According to the report received, the hip joint showed no abnormality. Radiogram taken on the day of admittance, showed a circumscribed, rarefied area distal to the upper femoral epiphysis.

The temperature gradually came down, and 1 month after admission remained at 101 degrees F., with daily remissions of ½ to 1 degree. With the application of traction the pain diminished to a marked degree.

The blood culture made on March 7 was sterile; on May 7 a fluctuating mass, which had recently developed

Fig. 1. Typhoid infection of the hip joint. The disease has involved the head and neck of the femur as well as the acetabulum.

over the great trochanter, was aspirated. The tap contained blood and pus, which according to the laboratory report, contained staphylococcus aureus and albus in culture. On June 1, the abscess cavity was opened, the trochanter bared, and the underlying bone curetted. The granulation tissue and pus removed were cultured and showed the presence of staphylococcus aureus. Early in July the temperature rose somewhat, remaining continuously at 102 degrees F., with only very slight morning remissions. There was only a scanty discharge from the wound, and the X-ray showed very little extension of the disease process in the bone. Nevertheless, the general condition of the patient noticeably declined. The liver and the spleen became enlarged. Blood culture made on July 20 was sterile. He was transferred to the Montefiore Hospital, where the symptoms of amyloidosis became prominent, and he died in November, 1925. The duration of the illness was 11 months. In this case a focus in the trochanter and the neck of the femur, which was apparently circumscribed and which did not penetrate the joint, was the cause of a rapid decline and death from amyloidosis within a comparatively short time.

As a general rule, the patients who die within a short time after the onset of the disease are characterized by a staphylococcus bacteriæmia. In the case just described, however, the blood culture was sterile, and in this respect the case is somewhat unusual. As a general rule, such cases make at least a partial recovery and run a course similar to that which obtained in the Cases 9 and 10.

Fig. 2. Gonococcus infection of the hip joint resulting in complete synostosis. The focus in the head and the acetabulum is well shown.

In the next case, on the contrary, the course was an unusually long one, and amyloidosis occurred only after a prolonged period of apparently good health.

Case 14. C. K., was admitted to the Mt. Sinai Hospital, April 28, 1923. He was discharged July 24, 1923. Diagnosis: pyarthrosis of the right hip joint. Operation included incision and drainage. The chief complaint was pain in the right knee of 7 weeks' duration. Patient did not recall childhood diseases. He was operated upon for an abscess of right thigh 14 years ago. A nasal operation was performed 3 years ago. Present illness began about 7 weeks ago, when patient was awakened by severe pain in the right knee. He applied iodine and in a few hours the pain disappeared, only to reappear again 5 weeks ago. This time pain persisted and patient went to Lincoln Hospital, where X-rays of hip and knee revealed nothing (to patient's knowledge). He was put in "Balkan frame" for 5 days, but could not stand the pain, and therefore went home. During this time he had fever varying between 101 and 102 degrees F. Pain was most severe in the knee, radiating to right hip, and sometimes to the leg and the foot. Pain was worse on movement.

Examination of extremities revealed the right lower extremity apparently shorter than left, the right thigh adducted, and the leg flexed. There was atrophy of thigh and leg muscles on the right. The knee and hip were very tender, but there was no swelling, no redness, or heat. The knee could not be fully extended, but could be fully

Fig. 3. Streptococcus infection of the hip joint as a complication of mastoiditis. There is marked involvement of the head of the femur and the acetabulum. (Case 2.)

Fig. 4. Streptococcus infection of the hip joint. The radiogram shows the rarefaction of the head and neck of the femur, although the clinical signs were those of what was formerly believed to be the synovial type of arthritis. These conditions are now usually considered to be characteristic of acute osteomyelitis. There never was suppuration in this case and the patient made a complete recovery without operation. (Case 3.)

flexed. The thigh could be flexed on abdomen but could not be moved in other directions. On all attempts at movement, there was marked pain. Over the hip posteriorly there was a scar of the operation of 14 years ago. No bone tenderness was noted. When the patient was on his back there was a marked lordosis of the lumbar spine. Patient was unable to walk or stand. The left extremity was negative. On June 13, a fluctuating point beneath right groin was aspirated and thick pus was obtained. The abscess was incised and about 500 cubic centimeters yellow brown pus was evacuated. On exploration with examining finger the abscess was found to communicate with the hip joint. On July 5, the patient complained of pain in the knee but there was no tenderness or swelling. The wound in the hip was being dakinized. The tubes were being shortened gradually. There was only a slight discharge. Patient was still running a low grade temperature. On July 11, a plaster spica, with a window to expose the wound, was applied. On July 23, the temperature was down and patient was able to get around on crutches. He complained of some pain in the knee. The general condition was much improved. Blood examination for tuberculosis fixation was negative. Animal inoculation with 3 cubic centimeters of pus emulsion from hip joint was negative. Patient entered hospital a second time on July 29, 1926. He was discharged August 8. Diagnosis: femoral abscess; chronic osteomyelitis. Operation: incision and drainage. Result: improved. Chief complaint was pain in the right hip for 2 weeks.

Local examination disclosed a localized swelling 5 centimeters in diameter over a scar extending a few centimeters above and below Poupart's ligament. The swelling fluctuated, was warmer to the touch than the skin surrounding, and was quite tender.

On August 23, 1926, patient entered hospital for the third time, with history of fainting spell and temperature of 101.5 degrees F. He was discharged September 21. Diagnosis: chronic osteomyelitis of right hip. Complications: amyloid disease of kidneys. X-ray report, August 27, 1926: stereoroentgenograms of the right hip showed chronic osteomyelitis of the head of the femur and its acetabulum. There was marked sclerosis and probably ankylosis. No sequestra were seen.

Physical examination revealed chronic osteomyelitis of the right hip as on previous admission. Patient ran a persistent elevated temperature up to 101.5 degrees F. for period of 10 days. Marked induration and tenderness were noted in upper one-third of the thigh. Large abscess cavity evacuated after 10 days' stay in the hospital. Temperature came down to normal. At the end of the third week in the hospital, patient developed bilateral œdema of the extremities, with puffiness of the eyes. Blood chemistry revealed cholesterol 214. Urinalysis showed albumen 3+ and hyaline casts. The œdema gradually disappeared. Patient was discharged on September 21 with advice to return to the out-patient department for further observation.

He came to the outdoor clinic for periodic examination. The urine continued to show the presence of albumin and casts. The sinus tract in the right groin opened and drained at irregular intervals. An X-ray picture taken in January, 1929, showed the head of the femur apparently synostosed with the acetabulum. There was an area of rarefaction immediately beneath the articular surface of the head, which was continuous with a similar one in the superior border of the acetabulum and the ilium above it.

Toward the summer his health noticeably declined. He had much pain in the hip, and the old sinus drained continuously. In July he was so ill that he was admitted to

Fig. 5. Radiogram of the hips of a patient who suffered from a streptococcus infection. The disease has subsided and the recondensation of the bones is advancing. (Case 4.)

the Montefiore Hospital for treatment. Here, although the albumin and casts in the urine persisted, and the spleen and liver continued to enlarge, he improved for a time, but the improvement was only temporary. There soon appeared œdema of the extremities and ascites, and he gradually lost strength, and died from amyloidosis 2 months after admittance to the hospital. The duration of the illness was 29 years. There was a quiescent interval of 14 years. This long period was, I think, due to the fact that he had almost complete synostosis of the articulating bones.

These 2 cases present the extremes of what usually happens in these conditions. As a general rule the course of the disease in the cases of more or less localized staphylococcus osteomyelitis of the hip joint is neither so short in the acute cases without bacteriæmia nor do such long periods of complete quiescence occur in the more or less chronic forms of the disease. The cases just described must, as far as the course of the disease is concerned, be considered exceptional. As a rule, the disease pursues the course which, in its principal features, resembles that which pertains to the Cases 8, 9, and 10 already mentioned. The condition in the latter had not at the time they were last seen reached its terminal stage, but from experience with a large number of these cases, I do not hesitate to predict that these, just as in the cases last mentioned, and the vast majority of the cases treated by conservative surgery that have come to me during the past 25 years, will sooner or later succumb to the disease itself, or the sequelæ and complications to which it gives rise. My conviction, which has grown stronger with years of added experience, is that staphylococcus osteomyelitis involving the hip joint is a most intractable condition and always leads sooner or later to a fatal termination when treated according to the generally accepted teaching here in the United States at the present time.

Fig. 6. Radiogram of the hip joint of a patient who recovered from a hæmolytic streptococcus infection with complete restoration of function. (Case 5.)

Much to my surprise, I have found, as my studies on this subject have progressed, that the results from conservative surgery as generally practiced in most of our large hospitals were, in spite of the vast improvement in surgical technique and hospital facilities, far behind the results obtained by the radical measures employed in the last decade, when resection of the hip was practiced, as a routine measure, in all cases of acute coxitis with symptoms of sepsis.

In some of these cases, it is true, the hip was resected when so radical a procedure was unnecessary or even contra-indicated. Thus I find

Fig. 7. Ankylosis of the hip joint as a result of a hæmolytic streptococcus infection. (Case 6.)

Fig. 8. Dislocation of the hip as a result of hæmolytic streptococcus infection. (Case 7.)

Fig. 9. The dislocation of the hip joint shown in Figure 8 after reduction. (Case 7.)

cases reported in Klemm's monograph on osteomyelitis in which resection was performed in very young children, even in streptococcus infection, or in older children in whom, from the nature of the symptoms as described, such a practice is contra-indicated. But when this operation was practiced in suitable cases and at the proper time, as it was for instance in Koenig's clinic in Tuebingen, the operation was often a life saving measure, and in a great many instances saved the patient years of suffering and invalidism. Thus Koenig[1] reports the results in 75 cases of resection of the hip for acute suppurative coxitis. Only 6 were discharged from the hospital with sinuses. The majority of the cases were well and able to walk in between 6 and 8 weeks after the operation. Nine died, and 65 completely recovered.

It is to be noted that in the cases reported by Koenig, resection was performed in only those in which there was a clearly demonstrable suppurative osteomyelitis. Koenig still believed that some of the cases that came to him were synovial in type, and therefore none of the cases were operated upon during the early stage of the disease even when, as rarely happened, the patient was brought to the hospital at the beginning of the illness.

In this country, on the other hand, patients suffering from these conditions are brought to the hospital much earlier than they are abroad. Most often they come in during the acute stage, when the destruction of the tissues is not advanced even in the staphylococcus infections, and when the differential diagnosis from the ordinary clinical findings, even if it is considered, is difficult or impossible to substantiate. The surgeon hesitates to operate when there are no signs of pus or he finds that simple incision and drainage, or even an expectant attitude, often leads to an amelioration of the symptoms. Under these conditions the patients suffering from the streptococcus and pneumococcus form of the disease finally recover with or without a certain amount of disability, and those with the staphylococcus forms either die or leave the hospital with a more or less disabled hip joint, and most often with a discharging sinus.

Thus it has come about that in this country at any rate, resection of the hip has been entirely abandoned as a routine measure and conservative operative surgical measures are more and more generally employed, in not only the less serious cases where such measures are frequently harmful, but they are also employed in the staphylococcus infections where such measures are totally inadequate. In my experience, as exemplified by the illustrative cases here recorded, neither the conservative nor the radical treatment is effectual when used as routine measures.

When resection is employed in all cases in which the early symptoms are acute and alarming, without reference to the nature of the infection, many cases are unquestionably subjected to operation

[1]Beitraege zu den Erkrankungen des Hueftgellenks.

Fig. 10. Recurrent staphylococcus infection. The disease is still active after 8 years. (Case 10.)

Fig. 11. Streptococcus coxitis treated by operation. This condition is most often met with by those who see these patients late. (Case 11.)

when even conservative operative procedures are contra-indicated. On the other hand, when all patients are treated by conservative surgery, even in the presence of outspoken evidence of suppuration and massive bone necrosis, the results are poor indeed, and many patients are doomed to die after perhaps years of disability and invalidism.

It is hardly necessary to multiply the examples. The cases of streptomycosis I have described, show very clearly that these conditions are curable without an operation no matter how alarming the symptoms may appear during the early stages provided the proper mechanical measures are instituted. When the mechanical measures are neglected or inadequate as in the Cases 11 and 12, the patient may recover from the infection and may remain free from recurrences, but he is left with a deformed or dislocated hip, and more or less complete and permanent disability. On the other hand, the cases of staphyloccocus infection illustrate the usual result when only conservative operative measures are employed. In these the recovery, should it occur, is rarely permanent; the patient after a long siege of acute and dangerous illness is left with a deformed hip and with a secreting sinus which may remain open and active over long periods of months or years, and he finally succumbs to an acute recurrence or to chronic, suppurative, multiple foci and amyloidosis.

Even in some of the very few patients that apparently recover completely, and apparently remain well for years (Case 14), the danger of recurrence and terminal amyloidosis remains a constant menace. Few general surgeons have the opportunity of following these cases over a period of years, and few if any, are confronted with the end-results as they are met with in orthopedic practice and institutions like the Montefiore Hospital, where the terminal conditions that result from this disease are only too painfully evident. It is unnecessary, nor does space permit the recording of the many cases of this nature that I have encountered in the institution mentioned, during the past 20 years. Here we always have numerous cases of this nature, that remain for long periods in custodial care until death terminates the patient's suffering.

Fig. 12. Early stage of streptococcus infection of the hip joints. The bone changes are difficult to determine. (Case 12.)

Fig. 13. A later stage of the disease as shown in Figure 12. The patient has been subjected to arthrotomy. (Case 12.)

I cannot at the present time report in detail the statistics of a large number of cases in order to show that well directed radical treatment in staphylococcus is the only method that is likely to afford permanent relief in this condition. The statistics from Koenig's clinic are quite sufficient to indicate that the conception of the disease here advocated, is well founded. Here only a few cases need be recorded to illustrate the results of properly applied radical surgical treatment as compared with the so called conservative measures usually advocated.

Case 15. A. G., was admitted to the Polyclinic Hospital on March 3, 1903, with the following history. About a year ago he became suddenly very ill, with great pain in the left hip, followed by chills and high temperature. He was seen by a number of physicians, and finally a large abscess over the left hip was opened. After several months the temperature subsided and he felt somewhat better, but the sinuses in the groin and the buttock which remained after the incision continued to drain. He had flexion and adduction deformity and total loss of motion in the hip joint, and he was obliged to use crutches to get about. He was admitted with the diagnosis of tuberculosis of the hip. But because of the acute onset and the rapid course, I felt that there could be no doubt that he was suffering from an osteomyelitis of the upper end of the femur, and advised resection. This was declined on the advice of the family physician. It was decided to correct the deformity of the hip and to treat him by immobilization. A month after the long spica was applied, a short abduction spica was substituted, with which he was able to get about with the help of crutches. There was less pain, but the sinus continued to drain rather profusely. He remained in fairly good condition generally, until June, 1903, when the condition again became acute. He had fever, pain in the hip and knee, and was unable to walk. Rest in bed for about 3 weeks led to some improvement, but the fever continued and there was much discharge from the sinuses. Toward the middle of July, he was more cachectic and the local condition remained unimproved.

On August 2, resection of the hip was performed. A Langenbeck incision was made. A large abscess cavity which communicated with the joint interior was entered. The head of the femur was separated from the neck at the epiphyseal line and was synostosed with the upper border of the acetabulum. In the neck there were a number of cavities filled with granulation tissue and sequestra. The neck of the femur was resected near the trochanter; the head of the bone was removed from its attachment to the acetabulum, and after chiseling away all the dead bone from the acetabulum, the end of the resected neck was placed therein. The wound was only partly closed and drained by and through tubes, and the limb was placed in an abduction spica. The drains were left in place for about 2 weeks, and then replaced by rubber dam. The latter was removed about 3 weeks later.

Patient was quite ill for some days after the operation, and ran a febrile temperature for about 3 weeks. He was discharged from the hospital at the end of 6 weeks, wearing a short plaster spica. The sinus discharged thin, purulent material for about 3 months after the operation, but finally closed. He wore the plaster spica for about 4 months. When it was removed the hip appeared firmly ankylosed in abduction and slight flexion with a little eversion. He was able to walk without assistance, and had no pain or discomfort.

I saw this boy at intervals for about a year after he left the hospital, and during this time he continued in good health, and had no symptoms from the hip. The shortening appeared compensated for, by inclination of the pelvis. I then lost sight of him. He appeared in my office in January, 1925. He has never had any recurrence of the suppuration in the hip joint; he has walked well without pain, and only a slight limp throughout his school life. During the past few years he has grown much heavier, and has been compelled to be on his feet a great deal. For about a year he has noticed that he was not walking so well, and that the leg appeared to grow shorter. On examination the hip was found to be firmly ankylosed in adduction.

On February 6, I performed a subtrochanteric osteotomy of the femur to correct the deformity. He was in plaster for 3 months. When I last saw him a year ago, he was walking well with the limb abducted and firmly fixed. He has no discomfort, and is able to be on his feet most of the day. The abduction takes care of the actual shortening. The condition of the hip as shown by X-ray film is reproduced in Figure 16.

Case 16. D. P., was admitted to the Montefiore Hospital, December 19, 1923, with the following history. He was in good health up to November, 1922, when, following a cold, he felt pain in the dorsal spine, which radiated to the head. There was some fever and general weakness.

Fig. 14. A still later stage of the disease as exhibited in Case 12. The child has been in traction with both hips in flexion and adduction. Note that the hip in which the disease had up to this time been unsuspected, is now dislocated.

Fig. 15. Radiogram of the hips from Case 12 after the disease had completely subsided.

Three days later, the pain became localized to the outer side of the left thigh. He was admitted to the Beth Israel Hospital, where he remained for a year. During this period he suffered intermittently from pain in the thigh, and fever up to 102 degrees F. The left thigh was incised for relief of abscesses a number of times. An abscess in the right forearm was also incised and drained. A plaster spica to the limb was more or less continuously worn during his stay in the hospital.

On admittance to the Montefiore Hospital the findings were as follows: Patient was a well developed but thin and anæmic boy who showed signs of a wasting illness. The internal organs showed no gross abnormality. A scar 5 centimeters in length was present on the right forearm. Motion in the joints was normal. The right lower extremity showed no abnormality. On the left lower extremity there was a scar 18 centimeters in length over the lateral surface of the thigh. There was also a scar about the size of a half dollar below the anterior superior spine of the ilium. The motion in the hip joint was more or less completely restricted and the patient complained when one attempted to move it. There was some loss of motion in the knee joint. The foot was fixed in equinus and was painful to passive motion. The left extremity was 2 centimeters shorter than the right.

The sinuses re-opened soon after patient entered the hospital. His condition remained unchanged until April 17, 1924, when it was noted that he had had more pain in the hip, some temperature rise, a considerable increase in the discharge from the sinuses, and a marked deterioration of the general health during the previous 2 weeks.

On June 11, an incision 4 inches in length was made over the anterior surface of the thigh, extending downward from the anterior superior spine of the ilium; the joint was explored and curetted. Considerable dead bone remained. Three days later an abscess over the outer side of the thigh was incised. All the wounds were dakinized. Two days later two more openings appeared on the posterior lateral surface of the thigh.

On July 30, all the sinuses, 6 in number, were discharging freely. For the past few days the patient had been complaining of pain in the thigh. He had been restless and unable to sleep. Temperature was up to 102 degrees F. Patient felt better and the pain had almost disappeared.

On February 15, 1925, examination was again made. The discharge from the abscesses gradually had diminished during August and September, and he was fairly well during this time. Early in January, the swelling and the pain in the hip gradually grew more pronounced; and a few days ago the abscess again opened spontaneously. Since then he has been somewhat relieved. From November 15, 1925, to February 24, 1926, he was given radiotherapy. The disease was apparently somewhat mitigated though he suffered from more or less acute recurrences until February 5, 1927, when the condition appeared quiescent, and he was discharged from the hospital. Repeated radiograms taken between this date and January 28, 1925, are reported to have shown a considerable advancement of the disease. On the latter date the process was reported considerably improved.

Fig. 16. The result of early resection of the hip (Case 15) for staphylococcus infection, and subsequent osteotomy for adduction deformity.

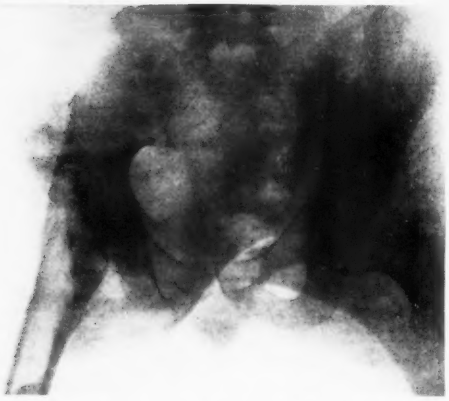


Fig. 17. Late resection of the hip for staphylococcus infection. (Case 16.)

Fig. 18. Radiogram illustrating the persistence of a metaphyseal focus in staphylococcus infection in a young child. Although the focus has given rise to no symptoms for a considerable period, it has nevertheless given rise to metastasis.

Patient was readmitted November 13, 1928. He had been working since his last discharge from the hospital. Just before readmittance he suddenly felt great pain in the left hip and was unable to move. The sinuses were not discharging. They were re opened by incision and discharged profusely.

On November 23, 1928, radical operation was done. Through a Langenbeck incision I resected the neck of the femur close to the greater trochanter. The acetabulum was curetted and some bone from the ilium above it was also removed with the chisel. The wound closed without drainage and the limb was enclosed in a plaster cast. Patient was very ill immediately after the operation. The temperature rose up to 104 degrees F., and he suffered great pain and prostration. Normal saline hyperdermoclysis and proctoclysis were given a number of times. On December 5, the wound was partly opened for drainage. Discharge from the wound was somewhat profuse at first but it gradually diminished; the temperature came down and the general condition soon improved. By Christmas the discharge was slight. In January, 1929, he was up in a spica bandage and in March he was able to walk without discomfort, although he still wore the plaster spica. During the summer the spica was discarded, and he was able to do light work in the hospital. He still had a very slight discharge but the wound required dressing only once a week when there was only a small spot on the gauze.

February 2, 1930, he reported for examination. He walked well, had no pain, and the general health was excellent. He compensates the ankylosis of the hip by moving the pelvis on the other hip joint, and there was remarkably little limp. He was working in the hospital and had not been laid off for the past 6 months. There was occasionally a very minute spot of discharge from a minute sinus in the operation scar. The radiogram of the hip taken 6 months after operation is shown in Figure 17.

The first case is a typical example of a staphylococcus infection of the hip joint treated according to the more or less generally accepted method now in use in this country. This boy after the usual conservative treatment continued to be acutely ill for several months. His temperature was high, and as no attempt was made to immobilize the hip joint, he suffered great pain, and he came to us with a badly deformed hip and a secreting sinus. The hip was resected, and he left the hospital 6 weeks later with the joint immobilized in a plaster spica. There was still some little discharge from the wound, but the acute symptoms had subsided; he was free from pain, and his general health showed marked improvement. The wound continued to secrete a small amount of pus for several weeks when it healed completely.

He remained well, without symptoms from the joint, able to attend school, and later to work until 5 years ago. He then returned to me with the complaint that the shortening of the limb interfered with some of his activities. The adduction deformity which had in the course of years gradually ensued, was corrected by subtrochanteric osteotomy, after which he was entirely relieved of all symptoms, walked well, and was able to carry on a large business that entailed a considerable physical as well as mental strain.

The second case was reported for 2 reasons. First, because of the relief obtained from resection, although the disease had persisted over a very long period; and, second, because it brings out very well, the fact that, unless all the diseased bone is removed, complete cure may not ensue. Thus in this instance the ilium was quite extensively involved as well as the head and neck of the femur. This I did not fully realize at the time of the operation, and owing to this over-

sight, I did not remove sufficient bone from the acetabulum, and the adjacent portions of the ilium. Hence although the patient (2 years after the operation) walked well without pain and with very little limp, he still had a sinus, very minute and only occasionally giving rise to an exceedingly small amount of discharge it is true, but still enough to indicate that the operation was not so extensive as to carry the resection well into normal bone.

It must be strongly emphasized, however, that although occasionally one may save a patient by resection after the disease has existed for a considerable length of time, in the vast majority of the cases the life of the patient, certainly his well-being, is seriously jeopardized when so long a period is allowed to elapse before resorting to this measure. For such patients are threatened with secondary foci, as is exemplified in Cases 9 and 10, rather early in the disease, when the operation is nearly always unavailing; or the patient becomes so debilitated, because of the long continued suppuration and the recurrent bacteriæmia, or the disease becomes so extensive, as for instance in Case 9, that the operation offers little hope of success.

On the other hand, I am far from advocating that a radical operation be undertaken during the early stages of a staphylococcus infection of the hip joint, even when the diagnosis is assured. There are a number of reasons why this is inadvisable: First, the bacteriæmia or the sepsis that obtains during the early stage of the disease renders the operation one of much more danger than it is later when the intra-articular pressure has been relieved by incision and drainage. Second, because it is often difficult at this time to determine the extent and the location of the disease by means of the X-ray or by the appearance of the tissues when they are exposed.

It must be noted, that the mere fact that there are signs of acute coxitis and staphylococcæmia, does not always indicate that the disease is actually located within the capsule of the joint. It should be remembered that an osteomyelitis involving the bones of the pelvis adjacent to the hip joint, or one that involves the upper end of the femur on the distal side of the epiphyseal line often gives rise to an effusion into the joint and joint spasm before the joint is actually invaded. It is, of course, a grave mistake to open the joint under these circumstances.

It would lead too far to discuss the latter conditions at the present time; they are well described in the exhaustive textbooks on surgery. During the early stages the diagnosis is sometimes somewhat difficult and during the advanced stages of a virulent infection is often substantiated too late to be of avail in saving the hip joint and the patient's life. In the less virulent forms of the disease, I should say in the majority of cases, the fact that one has this possibility in mind, will often lead one to recognize the morbid condition, and its location. The situation of the abscess, moreover, often points to the source of the infection. Thus tumefaction or an abscess that occupies the dorsum of the ilium, or the pelvis, is fair assurance that the disease is situated in the ilium and thus the point of attack is plainly indicated. In such cases resection of the diseased portion of the bone not only prevents the spread of the disease to the joint but often brings the morbid process to an abrupt conclusion. It is unnecessary to illustrate the point here; the condition is well described in the literature and in the monographs on the subject.[1]

There are still other reasons why early resection in all cases of staphylococcus coxitis should be deprecated. These rest upon the peculiar development and anatomical conditions that obtain during infancy, childhood, and adolescence. These developmental and anatomical peculiarities have a very important bearing upon the location and the course of the disease, particularly as it affects the head and the neck of the femur.

It has long been known that micro-organisms elect certain circumscribed regions in the bones, as their favorite sites for localization correspond to the terminal blood supply of the affected bones. In the growing individual this lies in the metaphysis of the long bone. Here the blood supply is most abundant, and the blood current is retarded—ideal conditions for the localization of infective foci. Hence, as concerns the upper end of the femur, the primary site of the disease will vary with the age of the individual. In young infants in whom the head and the neck of the femur are still wholly cartilaginous, the disease will invariably be situated on the distal side of the epiphyseal line, and as a consequence distal to the insertion of the capsule. For this reason in the milder cases the disease runs its course without involving the head and the neck of the femur and without invading the interior of the joint. Moreover as the bones at this time are soft and friable massive necrosis does not take place; and as the tissues are less resistant than in older children the abscess will practically always seek a vent externally. In many of these cases, the abscess opens spontaneously before the diagnosis has been made;

[1] See Tillmann. Die Verletzungen und chirurgischen Krankheiten des Beckens. Lieferung 62a, 1905.

and at most, simple incision and drainage bring the disease to a conclusion. More virulent infections often course along the ossifying line and destroy the connection between the neck and the shaft of the bone, when the head and neck, more or less completely degenerate and there remains only a rudimentary connection between the shaft of the femur and the acetabulum. In many of the cases of so called infantile epiphysitis, there is, in spite of the apparently marked distortion of the head and neck of the femur, as seen in the radiogram, surprisingly little disability as the children grow older. Thus I have seen not a few adults who had suffered from this condition in infancy who walked without perceptible limp and suffered no inconvenience whatsoever from the results of the disease of early life.

It may, therefore, be concluded that a staphylococcus infection of the hip joint, even when the disease has actually invaded the joint interior, is a much milder condition during early infancy, than it becomes at a later period in life. It is true that in some cases the disease is very virulent and soon leads to a fatal termination; but if the child recovers from the bacteriæmia, the disease runs its course acutely, and there is rarely danger of recurrence and chronic suppuration.

It must be admitted, however, that although this is true in by far the majority of the cases, there are occasionally cases to be met with, in which the disease after the subsidence of the acute symptoms, runs a chronic course and gives rise to metastases even in the very young. But even in these I feel that radical measures are either contraindicated or difficult to evaluate. I have, for example, still in my care a case of osteomyelitis on the distal side of the proximal femoral epiphysis which originated when the child was 1 year old, in which a secondary focus appeared in the lower end of the tibia a year later, when as shown in the reproduction of the radiogram in Figure 18, the femoral focus appeared to have become circumscribed and was apparently undergoing spontaneous resolution. However, such cases are exceptional and I think that it is hardly open to question that staphylococcus infection in or near the hip joint in very young children and infants should be treated by conservative surgical measures; and that although it is true that a deep abscess should be incised as soon as there are signs of fluctuation, no radical measures should be instituted in these cases.

As the child grows older the local anatomical and developmental conditions change. The neck of the femur is formed by the proximal extension of the shaft of the femur and the epiphyseal line comes to lie within the capsule of the hip joint. As soon as this change takes place, osteomyelitis of the upper end of the femur, unlike the disease, as it affects other bones, where it only occasionally invades the neighboring joint by extension of the pathological process through and beyond the epiphyseal line, is situated within the joint capsule from the beginning. Under these circumstances when the abscess within the spongiosa breaks through the cortex it communicates directly with joint interior, causing a suppurative arthritis.

Obviously, there are no capital foci until the ossification center for the head has been laid down and has begun to grow. The controversy as to the comparative frequency of capital and cervical foci arose because this fact was not taken into consideration when compiling statistics in this regard. My own experience, which in great measure agrees with that of Koenig, has led me to believe that capital foci become more and more frequent as the child grows older, until adult life, when capital foci or diffuse infiltration of the head practically always usher in the pathological process. As ossification in the head and neck of the bone advances, the thickness of the epiphyseal disk that separates the head from the neck gradually diminishes and a stage is finally reached when they are separated from each other by a very fine line of growing cartilage. During this period the foci of disease appear on either side of the epiphyseal disk or in the subchondral region.

As Koenig has well shown, the pathological process in staphylococcus infection closely resembles the tuberculosis foci in their manner of localization and their manner of invasion. And, except that the morbid changes in the bones caused by staphylococcus infection progress much more rapidly, there is little to distinguish the terminal lesion from those of tuberculosis.

The disease as it occurs in the acetabulum is obviously subservient to the developmental conditions that obtain in this region. Here, too, the original focus lies extra-articular during early infancy; but in this situation the ossification centers are laid down much earlier than they are in the head and the neck of the femur. In fact, the bone arising from the pubes, ischium, and the ilium has advanced so far as to be contained within the joint before the end of the first year. For this reason, a focus laid down in one of the bones that make up the acetabulum, is intra-articular at a time when a femoral focus would still be outside of the joint. This is to say that primary intra-articular foci which appear during early life

originate and are often confined to the acetabulum. This inference is borne out by the fact that the abscess which appears in these cases usually points in the buttock.

Staphylococcus infections are as a whole, much less frequent in infancy and early childhood than are the streptococcus and the pneumococcus infections. Thus I have records of 20 cases with bacteriological examinations in children under 4 years. In these the streptococcus hæmolyticus was found in 8 cases and the pneumococcus in 6 cases. I have not searched the recent literature for confirmation of my own conclusions as to the comparative frequency of these infections in infants and young children, but in his book on osteomyelitis, Klemm, in speaking of osteomyelitis of the hip joint, reports 23 cases in children under 4 years of age. The bacteriological findings in these cases are strikingly similar to those in my own cases. In 9 he found streptococcus hæmolyticus; in 7 the pneumococcus; and in only 6 staphylococcus aureus. If we reckon the pneumococcus, which causes analogous changes, with the streptococcus infections we find that of the 20 of my own cases 14 of 20 and in Klemm's 16 of 23 were caused by organisms that cause morphological changes which differ radically from the more malignant staphylococcus infections.

Now it is a fact, which I continually verify by additional cases, that the streptococcus and the pneumococcus infections are much more frequently primarily located in the bones of the acetabulum than are the staphylococcus infections. The frequency with which one meets dislocation of the hip during the early stages of the disease in these infections certainly bears out this conclusion. In infants and young children, therefore, osteomyelitis primarily located in the acetabulum must be by far the most common condition: first, because the ossification centers appear earlier in this situation than they do in the upper end of the femur; and, second, because, in them, the disease is, in by far the majority of the cases, caused by either streptococcus or pneumococcus infection.

We may say with some assurance, therefore, that the acute suppurative or non-suppurative infections of the hip joint in infants and young children are much more benign conditions than they are in later life. There is less bone to undergo sequestration, there is less danger of permanent damage to the periarticular tissues even when the disease is due to the staphylococcus, and lastly the disease is most often caused by the less destructive organisms—the streptococcus and the pneumococcus—from which the patient may recover with perhaps some impairment of joint function, but without the danger of chronic suppuration recurrence and metastases. Hence, the question as to the therapeutic measures to be employed in acute coxitis during infancy and early childhood is not difficult to answer. In view of the facts here brought out it is clear that radical measures are seldom necessary. They are certainly contra-indicated in the cases due to streptococcus and pneumococcus infections, which form the largest contingent of the cases; and, although there is a question whether staphylococcus infection, in which a more or less circumscribed focus persists and which is for this reason likely to give rise to metastases, as for example in the case from which the radiogram is reproduced in Figure 18, should not be eradicated as soon as possible; it nevertheless remains true, that in the majority of the cases of staphylococcus infection at this time of life, the operation may, indeed should be, delayed until the conditions for this operation are favorable, that is, until the bones are so far developed that an ankylosis of the hip is assured.

For it must be emphasized that in resecting the hip for staphylococcus infection, the mere removal of the head of the femur does not satisfy the requirements for a permanent cure. The conditions are similar to those that obtain in tuberculosis in which it is necessary to insure a true bony synostosis, that is, the joint cleft must be completely ablated, and the connection between the articulating bones converted into dense bone if the disease is to be permanently eradicated. This, of course, is difficult to attain during early childhood, and it is for this reason, and for this reason only, that I am advocating delay in subjecting the patient to the operation at this period of life.

Now whereas infants and young children are apparently much more susceptible to streptococcus and pneumococcus infections than they are to staphylococcus infections, this relationship undergoes a radical change as the child grows, is as a matter of fact reversed. For in my experience, which is verified by statistics that already exist in the literature, the staphylococcus infection is much more frequently the cause of acute coxitis in later childhood and adolescence than is either the streptococcus or the pneumococcus; and it is at this period of life that the most typical cases of acute suppurative coxitis, such as have been exemplified above, are most frequently met with. Curiously enough, the relative frequency of these infections again undergoes a change as we reach adult life. Here the streptococcus and pneumo-

coccus, more particularly the former, again become the predominating, I might say practically the invariable cause of the disease. All the cases of staphylococcus coxitis in adults that have come under my observation have been recurrences of an infection that dates back to early life (as for example Case 14). Nor can I recall a single case of the disease in an adult in which I could not be certain, either from a bacteriological examination or from the course of the disease, that the condition was caused by either a streptococcus or a pneumococcus.

Acute streptococcus coxitis in adults, as exemplified by the Cases 5, 6, and 7 presents all the essential features that characterize the disease in children. There is never long continued suppuration or a chronic osteomyelitis after the subsidence of the acute attack; when there is an abscess this soon clears up after spontaneous perforation or incision; and when the rarefied bones are protected from injury and the articular surfaces are maintained in their proper relations, and the mobility preserved by gentle passive motion, the patient will often completely recover his health; and although for obvious reasons not so regularly, with a hip joint, that has lost little or none of its normal functional power. On the other hand, when these precautions are neglected the patient is left with a stiff and deformed hip and more or less completely disabled, a disability which can only to a certain extent be corrected by painful and time consuming orthopedic measures.

The observations here presented must, I think, help to clarify our views as regards osteomyelitis of the upper end of the femur involving the hip joint. They must, if my interpretation of the findings is accurate, lead us to believe that the disease is not, as has hitherto been taught, a more or less well defined single entity which can be treated by some typical standardized form of surgical or mechanical procedure. We find that it is not true that the morbid condition, the clinical course, and the termination is the same, irrespective of the invading organism. That, on the contrary, the character of the invading organism is chiefly if not altogether responsible for the changes that ensue, and for the ultimate conditions that arise, and the sequelæ that follow this disease.

I believe, and the facts as here presented bear me out, that we must divide the cases of osteomyelitis of the hip into two classes:

1. The streptococcus and the pneumococcus forms.
2. The staphylococcus forms.

The streptococcus forms differ from the staphylococcus forms in a number of very important details. In some cases the disease is mild and runs a short course and often ends in complete recovery. But the disease is not mild, as was formerly believed, because it is synovial in origin, or because there is simply a synovial effusion (the marrow in the epiphysis is here, as well as in the more serious forms, the original seat of the disease), but because the invading micro-organisms exert a much less serious deleterious effect upon the tissues. In the more serious forms of streptococcus infection, the constitutional reaction is profound; the pathological process spreads rapidly within the marrow of the epiphyseal ends of the bones, causing intense rarefaction, which leads to distortion of the head and neck of the femur or the acetabulum or both. The disease spreads to the joint interior and the synovial membrane, and finally leads to destruction of the joint tissues with deformity of the articulating end of the femur or dislocation. However, although the condition as a part of a general sepsis, may terminate fatally, as a general rule, after a more or less stormy or long continued illness, which leaves the patient seriously debilitated and with a more or less disabled hip, the disease finally subsides and, unlike the condition caused by the staphylococcus, it is very rarely, if ever, followed by recurrence. There is rarely profuse or long continued suppuration in these conditions. At times there is a seropurulent exudate which is occasionally tinged with blood. This exudate like that contained in the subcutaneous abscesses which are not infrequently found in streptococcus sepsis nearly always, rather promptly, subsides after spontaneous perforation externally, or after simple incision.

Streptococcus coxitis never leads to massive necrosis and sequestration. There is, it is true, diffuse infiltration of the marrow and often extensive rarefaction, but unlike the condition which prevails as a result of staphylococcus infection there are no large sequestra, and although infraction of the rarefied neck of the femur may, when the parts are roughly handled, occur, I have never found the head of the femur completely separated from the neck and free in the joint cavity.

These facts well apprehended, the indications for the treatment of this condition are clear. As there is no suppuration within the bone, as there is no sequestration, and as there is little danger of extension of the morbid process to the central marrow cavity, a radical operation is unnecessary. On the contrary, inasmuch as by far the majority of these cases will recover under conservative

treatment, radical surgery is to be deprecated. It is not only ineffectual but during the acute stage of the more serious infections it is an added menace to the patient's life. On the other hand, though radical operations are never called for, and by far the greatest number of patients recover without any surgical intervention at all, it does not follow that these conditions require nothing but the expectant and symptomatic treatment, that they so often receive when they are not heedlessly subjected to operation. Such a course may be less dangerous to the patient's life than an operation, but in all but the mildest cases, does nothing to prevent the irretrievable damage to the joint structures which, unless some precautions are taken to forestall them, must follow the pathological changes in the articular ends of the bones and the periarticular tissues. The bones are rarefied and the capsule is distended; hence, unless these structures are protected from the handling necessary for the care of a very sick patient, the neck of the femur will be fractured or deformed, the contours of the articulating surface of the head of the femur will be obliterated, or because of the absorption of the acetabulum rim the head of the femur will be dislocated, and the joint becomes fixed and permanently disabled. Seldom is this eventuality comprehended by the average surgeon or practitioner, and rarely does one see a case of acute coxitis late in the disease in which there is not some and often serious permanent disability. Cases 11 and 12 are typical examples of what one constantly meets with in practice and in the hospital and such results are only too often reported in literature.

The treatment for these conditions is simple and only rarely difficult to carry out effectively. Traction by means of adhesive plaster straps extending from the trochanter to the malleoli is a ready means of maintaining the surface of the articulating bones in their proper relations without at the same time completely immobilizing the joint. It must be well appreciated that the object to be attained is not only the relief of pain and the prevention of deformity but the preservation of the mobility of the joint. Traction properly applied relieves the joint spasm within a surprisingly short time. The patient soon becomes more comfortable; and, if applied early enough, that is before distortion, dislocation, or synostosis has occurred, gentle passive motion to maintain the mobility (varying, of course, with the intensity of the pathological process) is soon borne without too much discomfort. Gradually the motion may be increased and in the course of a comparatively short time a considerable range of motion may be established, not only in the cases that are apparently recovering from the infection, but even in those in which the temperature is still high and the constitutional symptoms are still profound.

By means of traction and assiduous attention to the carrying out of passive motion, I feel sure that I have been enabled to prevent the distortion, dislocation, and loss of motion so inevitable in many of these cases, when the disease is at all pronounced and extensive. In older children and in adults, it is easy to carry out by anyone who has the necessary knowledge and the modicum of skill in its application. Occasionally, it is true, some ingenuity and a considerable amount of patience and tact are required to carry out the treatment effectively. For obvious reasons it is impracticable in young infants. But in them the disease when virulent is nearly always fatal, and in the less virulent cases is less destructive than at a later age and, for this reason, it is not so likely to lead to serious disability even when the condition is left untreated. In older children and in adults there are sometimes complicating conditions (as for example in my Case 5, a patient in whom a very extensive bedsore on the sacrum necessitated the application of traction with the body prone), when some little skill is required to attain the effect desired; but on the whole no difficulties are encountered; and with care and patience and a little tact these patients can either be completely restored, or at least relieved with the joint synostosed in the most favorable position for function.

It must be emphasized, however, that the treatment must be inaugurated during the early stages of the disease. No treatment is likely to be effective after the joint ends and the periarticular tissues have been seriously damaged. I have had little success in restoring motion in joints synostosed even when the position was good. Nor can I feel so sanguine as to the end-results, although some authors report good results, after closed or open reduction of the dislocated hip. Except in the cases that have been seen very early, that is, soon after dislocation had taken place, have I been successful in maintaining the reduction permanently. I find them not difficult to reduce when synostosis has not occurred, but even in the cases, of which Case 7 is an example, in which the trochanter is transplanted down on the femur the hip has redislocated as soon as weight bearing was resumed.

It would unduly widen the scope of the present paper were I to enter into a discussion of the

details of the treatment of streptococcus infection of the hip joint. From what has been said it must be clear that streptococcus as well as pneumococcus infections of the hip, as well as of other joints, is a morbid process that differs radically from staphylococcus infection. That other than the incision of an abscess, surgical—certainly not radical surgical—procedures are contra-indicated, and that with reasonable care and intelligent supervision many, perhaps the majority, of the patients suffering from these conditions can be more or less completely restored to health without undue loss of the joint function.

If we now turn to the staphylococcus infections we must, if my interpretation of the observations here presented is correct, conclude that we have in them an entirely different morbid condition to deal with. The initial symptoms, it is true, and the general symptoms of sepsis are indistinguishable, but in their other clinical manifestations and in the local changes in the bones and the periarticular tissues they are altogether dissimilar. In contradistinction to the conditions which are inherent in streptococcus and pneumococcus infections, there is in staphylococcus coxitis always massive necrosis, which invariably leads to sequestration and chronic suppuration. The acute symptoms may, if the patient survives the sepsis, subside, but recurrences at longer or shorter intervals are bound to occur so long as the diseased bone remains *in situ*. This dead bone which is either attached or free in what remains of the joint cavity is never spontaneously extruded. Small sequestra come away from time to time but the larger ones remain behind and from time to time give rise to acute exacerbations and metastases. Even when the disease begins as a circumscribed focus, as for example in Case 13, the condition pursues its malignant course, and unless radical measures are instituted finally leads to a fatal termination. It is true that in some cases a long period may elapse before the morbid process again becomes active, but as in Case 14, sooner or later it again gives rise to acute constitutional symptoms, metastases in other bones, until finally the patient ceases as a result of the chronic suppuration and the consequent amyloidosis.

It should be understood that the cases here recorded, particularly Cases 9 and 10, are not selected because they are unusual. On the contrary, these cases are selected because they represent what one constantly meets with both in hospital and private practice. Just as in these cases the vast majority of the patients are brought to the hospital during the acute stage, the abscess is opened, the bone either drilled or curetted, and perhaps a sequestrum removed, and he is discharged after a more or less serious siege of illness, with either a draining sinus or with the disease apparently quiescent. He usually has the motion in the hip more or less completely restricted in a deformed position and in consequence is lame or must use some apparatus or crutches to be about. He may be fairly well for a while but the symptoms sooner or later return, when he is readmitted to the hospital, and the series of events of his first admittance are repeated. Again, he is discharged either quiescent or with a sinus, which may drain for weeks, months, or years, when the disease again exacerbates or gives rise to metastasis. This series of events is repeated time and again until the patient is either operated upon radically or he succumbs to a metastasis in one of the internal organs, general sepsis, or amyloidosis.

In an experience of at least 25 years I can remember not one patient over 10 years of age who has suffered from an acute staphylococcus coxitis in whom the disease did not become chronic or in whom the lesion healed spontaneously or as the result of conservative surgery. Only in one way have I been enabled to save such patients from the unhappy future so inevitably in store for them and that is by completely eradicating all the diseased bone and securing a bony ankylosis of the hip in good position. In these cases, unhappily, I still see no reason to change the attitude I felt compelled to assume toward tuberculosis of the hip joint in 1915. I still remain convinced that these patients are never cured until the joint is completely obliterated, and an end-to-end synostosis between the articulating bones has taken place. As concerns tuberculosis, it is now maintained in some quarters that, in the high altitudes of Switzerland, these patients get well with a normal joint. I have not seen a great many patients who have been favored with the treatment in these regions. But in the few that have come to my notice and whom I have had the opportunity to observe over a number of years, the cure did not seem to me to be permanent. In the majority of them exertion often brought on pain and spasm and only with the exercise of great caution in the use of the limb and excellent general hygienic conditions were these patients more or less free from symptoms. Considerable experience with similar treatment in this country does not, by any means, lead me to anticipate that our efforts in this direction will be successful. However, whatever may be the conditions as concerns tuberculosis

I am fully convinced from my own experience in these cases, and the results of conservative treatment as they come to me from many skillful surgeons, that so long as we have not a specific treatment for staphylomycosis our only hope of saving these patients years of suffering and a fatal termination is the complete ablation of the hip joint with ankylosis in good position.[1]

I freely admit that this is an admission that our surgical treatment in this disease is to a certain extent at least inadequate. We are, of course, substituting a mutilation for a cure. But this must remain true in many of the morbid conditions that come to the surgeon for operation because there exists no medical treatment likely to effect a cure.

However, although I must admit that complete restoration is a desideratum, I do not feel that an ankylosed hip is so serious a handicap that every effort should be made to secure a movable joint no matter what the pathological condition, despite the slender chance of success, the inordinate loss of time, and the trouble involved, and despite the hazards entailed. I have patients with such hips who have become so accustomed (particularly when the resection and ankylosis dates back to early youth) to lost motion, and so skillfully utilize the motion of the pelvis on the normal head of the femur, that they are practically unconscious of the disability, hardly limp, and are able to perform strenuous work without the least discomfort or fatigue. Resection of the hip without ankylosis for the relief of the condition we are now discussing cannot be too strongly condemned. This operation not only leaves the patient with an unstable hip joint, but unless the femoral stump later becomes synostosed with the acetabulum which causes adduction deformity and shortening, it lays the patient open to recurrent staphylococcus infection, which in the end, after months or years of incapacity and suffering, leads inevitably to his death.

How soon after the diagnosis is positive, resection should be undertaken cannot be stated categorically. I have found that, unless the conditions are progressing very rapidly and the general conditions are becoming more alarming, it is better to open and drain the abscess and await a favorable moment, that is when the temperature is approaching the normal and the general condition has taken a turn for the better, before resorting to the operation. On the other hand, when the morbid process is, as for example in Case 9, extending rapidly, particularly when it is extending toward the shaft as well as toward the ilium and the blood cultures continue to show the presence of staphylococci, the operation should never be delayed; for, once the disease has advanced to the marrow cavity of the shaft of the femur or has invaded the pubes or the ischium, the time when a radical operation is likely to be successful has passed and the patient's chances for recovery have vanished.

Once the inferences to be drawn from the observations here described are well comprehended, the differential diagnosis between the two morbid conditions should present no difficulty. The bacteriological examination of the blood or the exudate will nearly always reveal the organism. With the present day hospital and laboratory facilities, such examinations are readily obtained. In the very virulent forms of infection with either organism, the patient often dies before the diagnosis is substantiated. In the less serious cases, as has been shown here, there can be no harm in waiting for the signs that help to differentiate the two forms of infection. When coxitis is suspected, traction should be applied. This relieves the acute suffering within a comparatively short time, and thus permits of repeated, careful examinations of the affected region. When fullness over the hip joint or the periarticular structures is discovered, one must be on the lookout for deep suppuration. Only when one has assured oneself that actual fluctuation exists should one proceed to incision.

I have never regretted awaiting the unequivocal signs of deed fluctuation before entering the hip joint. Nor do I see any advantage, on the contrary I think it somewhat hazardous, to resort to repeated aspiration in an endeavor to establish the presence of an abscess. It is far better to maintain the traction and do nothing else until one is actually convinced that suppuration exists before resorting to surgical measures. By so doing, one often finds that one is dealing with a streptococcus infection and the disease can be brought to successful conclusion without an operation. It is true, of course, that the serious and sometimes ominous symptoms sorely tempt the surgeon to pursue a radical course, before the indications for doing so are decisive, but I feel that the surgeon who assumes an expectant attitude toward these cases and operates only in the presence of actual suppuration, will often be gratified by a surprisingly good result in what first appears to be rather a desperate case.

No doubt, with the rapid advance in the distribution of hospital facilities and the rapid strides that are constantly being made in bac-

[1] Mechanics and pathology of tuberculous hip-disease in their relation to its diagnosis and treatment. J. Am. M. Ass., 1915, lxiv, 1732.

teriological technique, blood cultures during the early stages of the disease will be available even in the most distant hamlet, and this period of anxious waiting will no longer confront the physician who for the present must forego these advantageous aids to diagnosis. As a matter of fact, the majority of cases of staphylococcus infection of the hip from the outlying districts do not reach the surgeon until the signs of an abscess or suppuration are unmistakable. Once signs of an abscess or suppuration are unmistakable, it is fair to assume that one is dealing with a staphylococcus infection; and when such an abscess has been incised and drained, and one finds it continues to discharge for a prolonged period, this assumption becomes an assurance; and when with these symptoms the radiogram reveals sequestra, the assumption becomes a certainty.

From what has been said, it is clear that I do not favor drilling or excavating the bones in order to search for an abscess in acute coxitis. It must be obvious that, if pus is present in the joint interior or in the periarticular structures, the periosteum has been penetrated and therefore an artificial opening is not required for drainage. On the other hand, if pus is not present in the joint or in the surrounding tissues after the disease has existed for some length of time, it must be assumed that one is dealing with a streptococcus infection and that neither pus nor a massive sequestrum is present in the bones. Hence, bone drilling is not likely to be of help in insuring the diagnosis. And because it is an unnecessary mutilation in streptococcus infection and is likely to lead to an extension of the morbid condition in the staphylococcus infection, it is to be strongly condemned.

In infants and very young children, the differential diagnosis is difficult to determine from the objective signs alone; but in them the fact that staphylococcus infections are less frequent than they are in older children and adolescents, and the fact that in them the disease is much less likely to lead to such marked irreparable injury should influence not only the viewpoint of the surgeon as concerns the diagnosis but also his course of action.

Upon the basis here advocated, moreover, the prognosis can be made with little of the hesitancy and sometimes without the pessimism that so often deters the surgeon from offering the patient or his relatives the consolation of a promise that, although the patient is seriously ill, his chances of recovery are not nearly so hopeless as the ominous symptoms that so often prevail in the earlier stages of the malady would lead one to suppose.

The evidence here presented seems so unequivocal that I can hardly believe that I have not made the subject clear. Should I, however, have failed to convince surgeons in general of the truth of the arguments I have used, that the treatment here recommended for acute coxitis is the only logical one, and for this reason have failed to find advocates for it, I feel compelled in closing to make a plea for more humanitarian handling of these patients. Nearly all the cases of acute coxitis that I see in general hospitals and in consultation in private practice are, whether they are operated upon or not, permitted to lie in bed and are moved, sometimes roughly, for the general toilet and dressings, without even a simple support to the limb. The children cry out when anyone comes near the bed, they shriek when the dressings are changed, and are so terror-stricken when they finally leave the hospital that sometimes months go by before they regain their mental equilibrium.

I am, therefore, pleading for a more intelligent and appropriate attitude toward these patients. No child suffering from a staphylococcus infection of the hip should be without a plaster spica whether a radical operation has been done or not. It takes little ingenuity and little skill to apply this support so that, when at least the skin surrounding the wound if not its interior is protected by vaseline gauze, the dressings instead of bringing the horror that so invariably accompanies them if these simple measures are neglected, are smoothly carried out without suffering to the patient. In the streptococcus forms traction is really what is required and always relieves the pain, and permits of efficient handling. As these patients rarely require frequent dressings and are so readily relieved by this procedure, it is hard to conceive why it should not be invariably resorted to in these conditions.

CHRONIC SUBDURAL HÆMATOMA

Simple Drainage as a Method of Treatment; Report of Eight Cases

HOWARD W. FLEMING, M.D., F.A.C.S., and OTTIWELL W. JONES, Jr., M.D., San Francisco
From the Department of Neurosurgery, University of California Medical School

OUR object in reporting this series of cases is to describe a simple method which has proved satisfactory in the treatment of chronic subdural hæmatoma.

In 1925, a complete consideration of this subject in an article by Putnam and Cushing brought this matter to the notice of the medical world and, especially, to the attention of those in neurosurgical practice. Many had seen isolated cases but few appreciated the frequency of this condition. Since 1925, many articles have appeared and several additional series of cases have been reported. The clinical and pathological findings have been described well and only need be outlined here.

We feel that our experiences warrant renewed emphasis of the following points:

1. The condition occurs at all ages, most frequently in young adults—usually males.

2. Subdural hæmatomata are relatively common and frequently follow insignificant head injuries.

3. The interval between injury and the onset of symptoms varies from a few days to many months.

4. There is no typical clinical picture. The symptoms and findings are bizarre and variable as illustrated by the occurrence of ipsolateral hemiplegia (Case 5). Papillœdema usually is present. Temporary remission of symptoms frequently occurs.

5. Early symptoms often are comparable to those ascribed to post-traumatic psychosis. Such symptoms, when followed by intracranial signs of general or local pressure or irritative phenomena, are most significant.

6. The spinal fluid pressure, when measured, is always definitely increased and, as a rule, the fluid is clear. Xanthochromic discoloration occasionally is encountered.

7. Superficial signs of head injury and X-ray evidence of skull fracture are found infrequently.

8. Frequently the condition is bilateral; in this series 50 per cent of the cases were found to be so.

9. A large percentage of cases are recognized only at autopsy.

10. Previous reports show that 83 per cent of the patients operated upon recovered.

The following case proved most interesting and instructive, and materially changed our viewpoint as to proper ways of handling such a condition.

Case 1. Bilateral chronic subdural hæmatoma. History of minor head injury 1 month previously. Right osteoplastic flap with removal of hæmatoma. Symptoms continued; relieved by simple drainage of subdural hæmatoma on the left side. Recovery.

D. P., German restaurant manager, aged 38 years, entered the University of California Hospital on January 31, 1927. The past history was essentially negative, except for the use of several ounces of whiskey a day. On January 1, 1927, patient struck the right side of his head on a concrete floor. He was not unconscious. A headache immediately developed which gradually increased in severity. January 23, examination was reported as showing ragged and infected tonsils, right sixth nerve palsy, and staggering gait. The fundi were negative. On January 25, adenotonsillectomy was done under ether anæsthesia, with delayed recovery from the anæsthetic. On the night of January 27, the patient became unconscious and extremely restless, and remained so for 4 days. On entry to the hospital, January 31, 1927, the patient was unconscious and could not be aroused; respirations were irregular. The left upper and lower extremities were moved infrequently; the deep reflexes were hyperactive on the left, with a suggestive Babinski. Pupils and extra-ocular muscles were negative; the fundi showed hæmorrhagic papillœdema of 3 diopters. Blood pressure, 140–70; pulse, 100; temperature, 37.6 degrees C.; respirations, 24; lungs, clear. X-ray plates of the skull were negative for any evidence of fracture. The blood count showed: hæmoglobin, 95 per cent; red blood cells, 5,590,000; white blood cells, 17,000; polymorphonuclears, 83 per cent; lymphocytes, 14 per cent; transitionals, 3 per cent.

Pre-operative diagnosis: possible subdural hæmatoma.

Operation February 1, 1927, under local anæsthesia, a burr opening was made in the right occipitoparietal region. The dura was tense and dark blue. On incising it, tarry, semi-clotted fluid escaped under increased pressure. A right osteoplastic flap was turned down. Before the dura could be opened, 50 cubic centimeters of hypertonic Ringer's solution was given intravenously. Beneath the dura, a typical organized chronic hæmatoma, covering the entire right hemisphere, was found and removed. The brain, however, remained tense and protuberant. Ventricular puncture yielded 5 cubic centimeters of clear fluid. Brain œdema or a subdural hæmatoma of the opposite side was suspected.

Four hours after operation, the patient suddenly developed Cheyne-Stokes respiration, with rapid pulse; blood pressure 110–65; temperature 40.8 degrees C. Lumbar puncture yielded faintly xanthochromic fluid under increased pressure. The cell count was 13. Upon withdrawal of the fluid, the respirations immediately became regular, but the patient remained stuporous. The following morning (Feb. 2, 1927) a right hemiplegia developed but his general condition remained unchanged. That afternoon, the patient again developed Cheyne-Stokes respiration; his temperature was 40.2 degrees C.; pulse

130. Following a lumbar puncture the respirations again became regular.

Operation February 2, 1927, under local anæsthesia, a burr opening was made in the left occipitoparietal region. The dura presented the same picture as had been found on the right side. The burr opening was enlarged and the dura incised, thus exposing the sac of a hæmatoma. The contents were washed away, but no attempt was made to remove the sac. The wound was closed with drainage. The patient immediately regained consciousness.

For the next 9 days there was gradual improvement in the patient's condition and the positive neurological signs cleared rapidly. At this time, his general progress was interrupted by the development of empyema, which required drainage. Not until March 25, did his temperature return to normal.

Although the patient had no positive neurological findings at this time, a burr opening was made in the left frontal area. The dura was not under pressure and, when opened, the collapsed sac of the hæmatoma was found. It was torn open and a very small amount of old clotted blood was irrigated away. The patient was discharged on April 9, 1927, and within 2 months returned to work. He has been seen at frequent intervals and has no complaints.

Microscopic examination of tissue showed a picture typical of chronic subdural hæmatoma.

Although familiar with the frequency of bilateral hæmatomata, our experience with this case further emphasized the necessity of exploring both sides at the first operation. In many cases the condition of the patient is such that bilateral osteoplastic operations would be too extensive and time consuming and would increase the surgical risk. Previously we shared the accepted view that complete removal of the sac as well as the contents was necessary to assure a satisfactory result; in view of our experience with this case we felt that small bilateral cranial openings with drainage should suffice to give temporary relief from pressure until the condition of the patient warranted more extensive measures such as an osteoplastic flap with complete removal of the hæmatoma sac. However, because of the entire absence of symptoms, this procedure was considered unnecessary. The satisfactory result led us to adopt less radical surgical measures, and we determined to treat subsequent cases of suspected subdural hæmatoma by simple drainage.

Briefly, the method is to make, under local anæsthesia, 4 trephine openings in the frontoparietal and parieto-occipital regions of either side (Fig. 1). The incisions are so fashioned and the openings so placed that they may be incorporated in an osteoplastic flap at a subsequent date if this is necessary. Small openings made in the dura expose the sac of the hæmatoma, which is torn open allowing the contents to escape. This is followed by through-and-through irrigation of the sac with Ringer's solution. The scalp incisions are closed without drainage.

CASE 2. Bilateral chronic subdural hæmatomata following a head injury 6 weeks previously. Simple drainage. Recovery.

J. B., laborer, aged 48 years, entered the hospital in a stuporous condition on January 14, 1928. The patient had been treated for syphilis 17 years before. He also had a right otitis media of several years' duration, and was a chronic alcoholic. Six weeks prior to entry, the patient fell 10 feet, hitting his head on a concrete floor. He was dazed but not unconscious and continued to work. Seven days after the injury, headache began, gradually increasing in severity. For the week prior to hospital entry, the patient was irrational, stuporous, and confined to bed. Examination on entrance to the hospital revealed the following: Patient was unconscious. There were no external signs of injury. There was a chronic otitis media, right. There was no cervical rigidity. The right pupil was larger than left, both reacted sluggishly to light; the disc margins were slightly blurred, with no measurable elevation. He infrequently used the right upper and lower extremities. Deep reflexes were equal; no pathological reflexes. Temperature, pulse, and respiration were within normal limits. Blood pressure was 125–90. Spinal puncture revealed: pressure, 350 millimeters of water; fluid, faintly xanthochromic; cell count, 6; Wassermann, 1 plus; Pandy, negative; colloidal gold, 0000000000; sugar, .088 per cent.

Diagnosis: bilateral chronic subdural hæmatomata.

Operation. January 14, 1928. The exposed dura was tense, deep blue, and slightly thicker than normal. The typical hæmatoma sac bulged through the dural openings. Through small incisions in the sac, greenish-yellow fluid spurted out 18 inches or more, followed by small blood clots. After through-and-through irrigations, the excavated cortex could be seen about 2.5 to 3 centimeters from the dura. The hæmatoma on the right side was less extensive.

The patient's improvement was immediate and before leaving the operating table he was able to give details relative to his accident and symptoms. The patient's convalescence was satisfactory and uneventful except for a transitory period of aphasia 18 days after operation, which cleared in a few hours. At this time there were no other neurological signs or symptoms. Follow-up examinations reveal the patient to be symptomless and sign free 3 years after operation.

CASE 3. Unilateral chronic subdural hæmatoma following trauma 3 months before entry. Simple drainage. Recovery.

E. A., negro, bootblack and janitor, aged 50 years, entered the psychopathic ward on May 29, 1928, in a stuporous condition. No history was obtainable. When aroused he looked about, but could not talk. The right pupil was larger than the left, but both reacted to light. Motor power in all extremities was uniformly decreased. There was some spasticity in the lower extremities. Deep reflexes were equal, but sluggish; there were no pathological reflexes. Blood pressure, 118–76; pulse, 50; temperature, normal; blood Wassermann, negative. Lumbar puncture showed clear fluid; pressure, 140 millimeters of water; 40 cells per cubic millimeter.

Over a period of 9 days, his condition gradually cleared and he was able to give a history of having fallen 3 months previously, but said he had not been seriously injured.

From June 7 to June 16, there was a definite progression of signs and symptoms and examination at this time revealed the following: the patient was conscious but uncooperative. There was marked aphasia. Tenderness was elicited in the left temporoparietal region. There were slight cervical rigidity, bilateral exophthalmos, right external squint, and unequal, irregular pupils. The fundi

showed bilateral hæmorrhagic papillœdema. There was slight weakness of the right arm and of the right side of the face. The deep reflexes were sluggish but equal, with bilateral Babinski. The following day the patient was more stuporous and was unable to speak. His blood pressure was 140–90; temperature, normal; pulse, 70.

Diagnosis: chronic subdural hæmatoma.

Operation. June 18, 1928: the exposed dura was tense; the color was normal on the right but dark blue on the left, posteriorly. When the dura was opened anteriorly on the left, the margin of the sac was just visible. Upon rupture of the sac, old tarry, semi-clotted blood escaped under pressure. The dura was then opened through the posterior burr hole and the dark blue shiny membrane lay immediately beneath. This membrane was also ruptured, allowing the escape of the same material. Through-and-through irrigation was then employed and many large and small blood clots were washed away. There was no evidence of fresh bleeding. The cortex, which appeared normal, was depressed from the dura a distance of 1.75 centimeters. The incisions were closed without drainage.

Immediate improvement was noted. Convalescence was slow but steady. At the time of discharge, 27 days after operation, the patient was up and about. He was free from symptoms and the eyegrounds had returned almost to normal. We have been unable to follow this patient's progress.

Case 4. Unilateral subdural hæmatoma following minor head injury 10 days before entry. Simple drainage. Recovery.

A. W., American, truck driver, aged 40 years, entered the San Francisco Hospital July 14, 1928. The past history was essentially negative; he used alcohol in moderation. On July 3, 1928, the patient was struck in the right parietal region, receiving a small scalp laceration. He was not unconscious. On July 5, he first complained of slight frontal headache and dizziness, but returned to work. One week after injury, his headache became more severe and at times he was mentally confused. He remained at home for 4 days, during which time he became progressively worse.

On admission to the hospital, he was semi-comatose, extremely restless, mentally confused, and was yawning continually. When aroused, he answered questions slowly. There was no speech difficulty. His face was expressionless. There was bilateral ptosis of the eyelids, greater on the left. The eyes showed a tendency to deviate to the left; the left pupil was irregular and larger than the right; both reacted sluggishly to light; there was a right external squint. The fundi showed early papillœdema without hæmorrhage. There was no weakness of the extremities. The deep reflexes were equal with the exception of the right patellar which was hyperactive; Gordon and Oppenheim, positive bilaterally; Babinski, negative. Roentgen-rays of the skull were negative for fracture. Blood pressure was 130–90; pulse, 60; temperature, 37 degrees C.; blood count was within normal limits; blood Wassermann was negative. Lumbar puncture revealed: fluid, clear; pressure, 500 millimeters of water. One cubic centimeter of spinal fluid was removed; cell count, 20 lymphocytes per cubic millimeter.

Diagnosis: chronic subdural hæmatoma.

July 16, 1928, lumbar puncture: pressure, 750 millimeters of water. Fifteen cubic centimeters of clear fluid was removed. The following day the patient was less stuporous, but had difficulty in naming objects; there was no stereognostic disturbance. His pulse rate was slowing.

Operation. July 18, 1928. The meninges and cortex appeared normal on the left. The dura exposed on the right side was dark blue and, when incised, the dark bluish

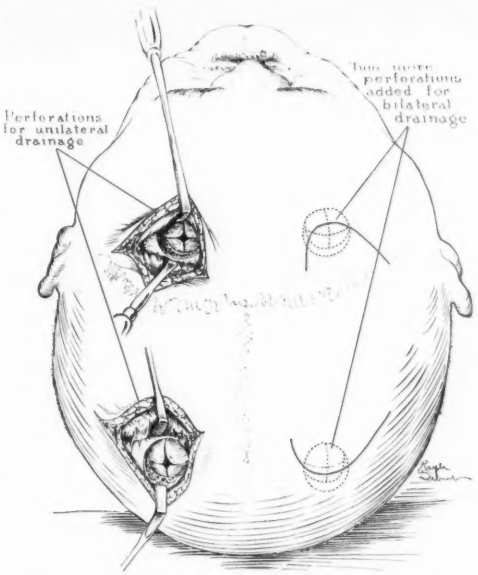


Fig. 1. Position of head at operation showing the relative locations of the trephine openings as used in the bilateral exploration of chronic subdural hæmatomata. Curved black lines (right) show the type of incision used.

membrane of the hæmatoma tended to herniate through the dural openings. The membrane, which was about 1 millimeter in thickness, was torn open, thus allowing the tarry liquid and small clots to escape. The cavity was irrigated through and through with Ringer's solution. There was no evidence of fresh bleeding. The cortex, depressed 2 centimeters, was of normal color, but the veins appeared congested. The scalp incisions were closed without drainage. Immediate improvement was noted.

The postoperative course was uneventful. The patient was discharged from the hospital 22 days after operation and returned to work in 2 months. At the present time (February, 1931) he is well except for an occasional mild headache and slight vertigo on stooping over.

Case 5. Unilateral chronic subdural hæmatoma with onset of symptoms 4 months after a severe head injury; ipsolateral signs; ventriculography. Simple drainage. Recovery.

J. C., Chilean, sailor, aged 30 years, entered the hospital on December 14, 1928. The past history was essentially negative. On September 7, 1928, he received a severe blow on the back of his head, on the left side. He was unconscious for 24 hours, bled from his ears and nose, and vomited repeatedly. Both upper and lower eyelids were ecchymotic. He returned to work the latter part of September, 1928, but continued to have spells of generalized headache and vertigo.

On December 12, 1928, during a quarrel, he was struck on the left temporal region and, shortly afterward he became dizzy and fainted. Examination was made on December 14, 1928. Patient complained of slight headache. Pressure in the left occipital region was somewhat painful. The pupils were contracted, equal, reacted to light; the fundi were not examined. The deep reflexes were normal.

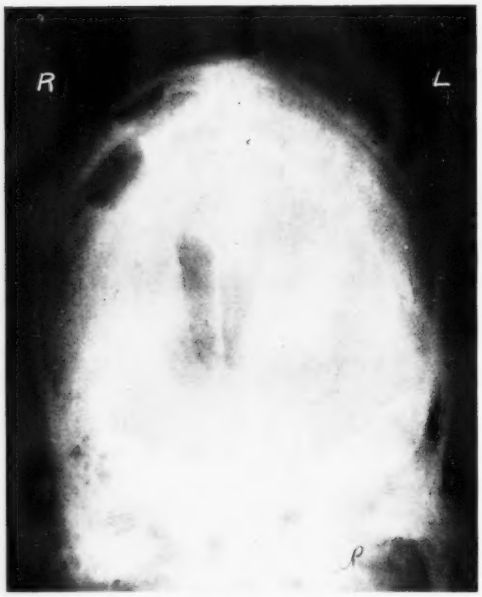


Fig. 2. Ventriculogram showing displacement of the ventricles to the right and deformity and decrease in size of the anterior horn of the left lateral ventricle. (Case 5.)

The blood Wassermann was negative. X-ray examination of the skull was negative for fracture.

The headaches became more violent; he had transient attacks of blindness, photophobia, and disturbance in color perception. On December 18, choked disc was noted on the left. Spinal puncture was done December 26: pressure was estimated to be normal; cytologic examination and culture were reported negative. On December 27, there was slight paresis of the left side of the body. On December 29, the eyegrounds showed bilateral choked discs. The attacks of blindness and the violent headaches continued. Spinal puncture was done January 2, 1929: pressure, 400 millimeters of water; cell count, 2 lymphocytes per cubic millimeter; Wassermann was negative; colloidal gold, oooooooooo.

On January 7, 1929, the patient became stuporous; his neck was stiff, with positive Kernig's sign; the fundi showed bilateral hæmorrhagic papillœdema; there was weakness of the left upper extremity; the deep reflexes were less active on the left; the Babinski was positive on the left.

Diagnosis: chronic subdural hæmatoma.

Operation. January 8, 1929. The clinical findings pointed to a lesion of the right hemisphere. Two burr openings were made on the right side, one anterior, the other posterior. There was no evidence of a subdural hæmatoma. The ventricle on this side was punctured. The clear ventricular fluid escaped under increased pressure. Thirty cubic centimeters of air were injected. Subsequent X-ray studies showed a displacement of the ventricles to the right; the left ventricle was smaller than the right (Figs. 2, 3, 4). The lowering of the intracranial pressure by removal of the ventricular fluid temporarily relieved the headaches and the patient regained consciousness.

Operation. January 12, 1929, burr openings were made anteriorly and posteriorly on the left side. The dura was tense and dark blue. Incision through it exposed the dark purplish sac of an old hæmatoma which tended to bulge through the small openings made in the dura. The sac was ruptured, thus allowing the contents to escape, and was irrigated with Ringer's solution. The incisions were closed without drainage.

Postoperative improvement was rapid and 5 weeks after operation, the patient returned to work. When seen in April, 1930, he was well.

This case is of unusual interest. Although the clinical history was suggestive of a subdural hæmatoma involving the right hemisphere, the lack of objective findings at the time of the first operation and the outstanding left hemiparesis, made it difficult to account for the patient's symptoms on this basis. At the time of operation the possibility of a deep lying lesion on the right side was considered most probable. Ventriculograms, as described, localized the lesion on the left.

Ipsolateral symptoms and signs have been described in several cases, but this was our only experience in this series. This case further emphasizes the necessity for bilateral exploration in suspected cases.

CASE 6. Bilateral chronic subdural hæmatoma. History of head injury 6 months previously. Simple drainage. Death.

S. H., German, mechanic, aged 35 years, entered the hospital on March 10, 1929, unconscious and *in extremis*. Six weeks prior to this time there had been a gradual loss of vision with headache, dizziness, and weakness for 3 weeks. He had been treated for influenza. When closely questioned, his wife and daughter vaguely remembered that the patient had sustained a severe bump on the head 6 months before entry into the hospital.

Examination revealed the following: The patient was unconscious and could not be aroused. Temperature, 37.6 degrees C.; pulse, 64; respirations, 28; blood pressure, 140–60. There were no visible signs of head injury, but there was a moderate cervical rigidity. The pupils were unequal, right larger than the left and a moderate bilateral papillœdema was noted. There was a spastic paralysis of the right arm and leg; bilateral Babinski. Spinal puncture revealed the fluid clear; pressure, 480 millimeters of water; slight increase in globulin; cell count, 1; Wassermann, negative. No X-ray examinations were made.

Diagnosis: subdural hæmatoma.

Operation. March 10, 1929. There were revealed typical subdural hæmatomata which were the largest we have encountered. On the left, the hæmatoma extended from the prefrontal to the postoccipital region and depressed the cortex 2.5 centimeters from the dura. A similar, but less extensive, hæmatoma was found on the right. The contents of the hæmatomata were irrigated away and the incisions were closed without drainage. Following operation, the patient's pulse became more rapid and the pulse pressure dropped to 40. He did not regain consciousness. Spinal puncture revealed normal pressure. The patient died 3 days after operation, with signs of pneumonia.

The patient was *in extremis* at the time of operation, and the fatal outcome does not negate, in

Fig. 3. Same as Figure 2; lateral view of left lateral ventricle showing uniform compression and decrease in size. (Case 5.)

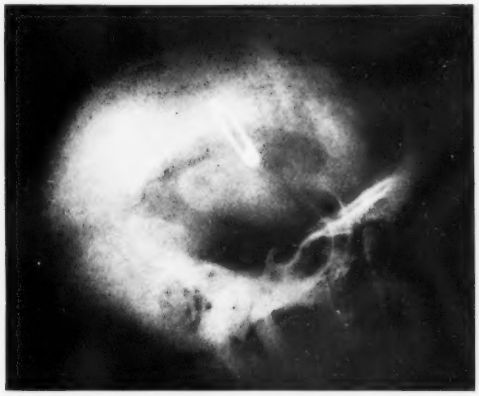


Fig. 4. Same as Figure 2; lateral view of right lateral ventricle. (Case 5.)

our opinion, the value of simple drainage in these cases. No autopsy was obtained and it is impossible to say whether or not there was continued bleeding. The low spinal fluid pressure indicated that the increased intracranial pressure had been relieved. It is our impression that death was caused by the prolonged intracranial pressure followed by cerebral anæmia and œdema after operation, aggravated by pneumonia.

CASE 7. Bilateral chronic subdural hæmatoma following severe blow on the chin 6 weeks before entry to the hospital. Simple drainage. Recovery.

C. K., Australian, engineer and garage foreman; aged 45 years. The past history was essentially negative. On June 29, 1929, the patient was struck forcibly on the chin by the handle of an automobile jack which slipped. He was unconscious for half an hour. For the next 2 days he suffered severe headache, had flashes of light before his eyes, blurred vision, diplopia, and tinnitus aurium, left. This cleared and for a few days he felt fairly well and was up and about. During the next few weeks he had an occasional bout of severe vertigo and projectile vomiting. Four weeks after the injury, the headache and vertigo became so severe that he was taken to the hospital. He remained in bed 6 days and felt improved. He was then allowed to sit up. For the first time he complained of difficulty in speech and, on attempting to walk, was aware of a peculiar sensation in the fingers of the right hand, which suddenly began to twitch. This was associated with a peculiar feeling in the left side of the face and blindness of the left eye. He felt faint; he was put to bed and gradually became stuporous.

On August 7, 1929, examination was made by a neurologic surgeon who reported: patient stuporous and difficult to arouse. Deep pressure elicited tenderness in the left subtemporal region. Pupils were equal and reacted to light. Fundi showed bilateral papilledema without hæmorrhage. There were right hemiparesis and hemihypesthesia of face, arm, and leg. The deep reflexes were more active on the right; Babinski was positive on the right; non-sustained ankle clonus on the right. X-ray examination of the skull was negative for fracture. Blood Wassermann was negative. Spinal puncture revealed: pressure, 800 millimeters of water; fluid, clear; cell count, 8; Wassermann, negative.

Diagnosis: chronic subdural hæmatoma.

Operation. August 8, 1929. The dura, exposed on the left, was dark blue and tense. It was thicker than normal and, when incised, the bluish sac of a subdural hæmatoma was exposed and ruptured, thus allowing the contents to escape. The cortex was depressed 1.5 centimeters from the dura. A similar procedure was carried out on the right side of the head, with identical findings. Both sacs were irrigated with Ringer's solution. The hæmatoma on the right side was not so large as that on the left. The incisions were closed without drainage. The patient recovered consciousness immediately and said that his headache had disappeared entirely.

All of his symptoms did not clear and 5 months later he was still complaining of vertigo, slight generalized headaches aggravated by stooping over, and tinnitus aurium left. The patient was readmitted to the hospital on January 3, 1930, on account of the persistence of the foregoing complaints. Examination was entirely negative except for diminished hearing in the left ear. Lumbar puncture was made and showed pressure 120 millimeters of water; fluid, clear; 125 cubic centimeters of air were injected. The X-ray examinations made showed the ventricles to be of normal size and symmetrically placed. The subarachnoid air was uniformly distributed.

Following this procedure the patient has shown definite improvement, but has continued to have mild attacks of vertigo and tinnitus in the left ear. At times these symptoms are severe and are associated with nausea and vomiting. At no time does he have headache. He is now doing light work.

This is the only patient in our series with continued symptoms. His complaints are those common after head injuries, but seldom are patients so free from headaches. That this is an industrial compensation case may be of significance.

The questions arise in this case: is the remaining sac of the hæmatoma responsible for the present

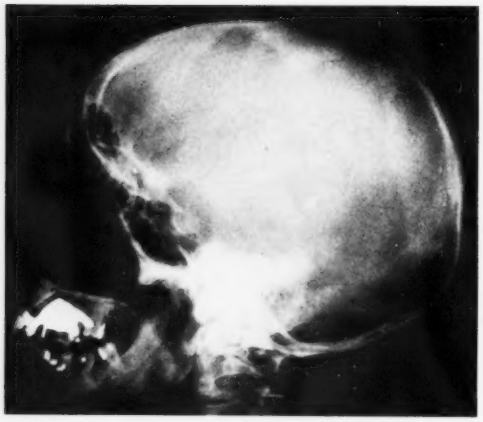


Fig. 5. X-ray plate of skull, lateral view, showing calcified pineal gland. (Case 8.)

Fig. 6. Anteroposterior view showing the pineal gland shifted to the left. (Case 8.)

symptoms? If so, is exploration warranted by means of an osteoplastic flap?

CASE 8. Unilateral chronic subdural hæmatoma following a minor head injury 9 weeks previously. Pineal shift. Simple drainage. Recovery.

P. R., English actor, aged 58 years. The past history was negative except for frequent attacks of influenza. On September 6, 1929, the patient bumped his head forcibly in the right parietal region. He was momentarily stunned, but noted no other effects. One week after the injury, a constant dull right sided headache developed. This was severe at times, was associated with nausea and vomiting, and was aggravated by stooping over. The second week there was improvement except for slight stiffness in his neck. The patient continued to work until November 4, though he was troubled by constant headache, marked generalized weakness, and difficulty in remembering his lines. Nausea was constant and he vomited several times, with relief.

On November 6, 1929, the patient was first seen by a physician. He was pale, weak, emaciated, unable to concentrate, and his memory was poor. Otherwise the examination was essentially negative. X-ray examination of the head showed the pineal gland to be shifted 5 millimeters to the left of the midline (Figs. 5, 6); there was no evidence of fracture. Blood pressure was 110–80; pulse, 70; temperature, 37 degrees C.; blood Wassermann, negative; blood chemistry, normal. Blood count: hæmoglobin, 94 per cent; red blood cells, 4,980,000; white blood cells, 12,600; polymorphonuclears, 83 per cent; lymphocytes, 14 per cent; transitionals, 3 per cent.

On November 8, there developed a slight tenderness over the right side of the head, right hemiparesis and hemihypæsthesia of face, arm, and leg. The deep reflexes were more active on the left; the left abdominal reflexes were absent; there were sustained ankle clonus and suggestive Babinski and Oppenheim reflexes on the left. The fundi showed early papilloedema without hæmorrhages. Hearing was impaired bilaterally, more on the left. Lumbar puncture showed pressure, 380 millimeters of water; fluid, clear; cell count, 1; chemistry, negative.

During the next 3 days, the patient became disoriented at times; he was unable to feed himself and acted very queerly.

Diagnosis: chronic subdural hæmatoma, involving the right hemisphere.

Operation. November 15, 1929, the dura on the right was tense and dark blue. Upon incising it, the shiny, dark blue sac of the hæmatoma tended to protrude through the dural openings. The sac was torn open, thus allowing the escape of the contents, which were under pressure, and was irrigated through and through with Ringer's solution. The scalp incisions were closed without drainage. Subsequent X-ray plates showed the pineal gland to be returning gradually to its midline position.

The patient made a rapid recovery with the exception that, on the third day after operation, he had visual hallucinations. He was discharged from the hospital, well, 3 weeks after operation and has remained so to the present time, continuing in his usual occupation.

This case illustrates the value of the pineal shift (1). In view of the fact that the pineal displacement and the clinical signs were in agreement, we felt that unilateral exploration was in order. The prompt recovery of the patient made further exploration unnecessary.

DISCUSSION

Other writers, particularly Rand (3), have suggested that modified methods might give satisfactory results, but, as far as we know, no one has reported a series of cases so treated.

Many questions naturally arise when considering the advisability of employing simple drainage. What is the possibility of immediate or delayed hæmorrhage? Does the remaining pathological tissue persist and may it prove to be harmful? If so, what future complications may result?

Inasmuch as complete surgical removal of the type of hæmatoma under consideration is possible and incomplete removal of pathological material is not an accepted surgical principle, we feel that the method of simple drainage is open to criticism. Nevertheless, we urge these advantages in its favor:

1. A relatively minor procedure is substituted for a formidable operation.

2. Exploration anteriorly and posteriorly, as described, minimizes the possibility of overlooking such a condition, which, in a certain percentage of cases is bilateral.

3. A negative bilateral exploration can be followed at once by the diagnostic procedure of injecting air into the ventricular system.

4. Local anæsthesia can be employed invariably.

5. The time which is required for the operation and the tax on the patient are reduced to a minimum.

The number of cases so treated is few and the time elapsed since the method was first used has not been sufficient to allow us to make an unqualified statement as to its worth. However, we feel that the immediate and remote results warrant its continued use in place of the accepted and more radical procedures.

SUMMARY AND CONCLUSIONS

1. Non-operative treatment of these patients has proved unsatisfactory.

2. Exploration through small trephine openings is a benign procedure and is indicated in suspected cases of chronic subdural hæmatoma.

3. Evacuation of the hæmatomata through small openings is efficacious.

4. In no instance has there been a recurrence of symptoms. Four years have elapsed since we first used this method of treatment.

5. In this series of 8 cases only 1 patient died; this patient was *in extremis* at the time of operation, and we feel that his death should not negate the value of the method of operation. Six, 2 of whom had bilaterial hæmatomata, are entirely well. One patient with bilateral hæmatomata complains of constant tinnitus and occasional attacks of nausea and vomiting. This is an industrial case and compensation neurosis may play some part. His symptoms are those commonly found with head injuries and may bear no relation to the subdural hæmatomata.

6. The pineal shift is of diagnostic value in this condition as well as in cerebral neoplasms.

REFERENCES

1. Naffziger, H. C. A method for the localization of brain tumors—the pineal shift. Surg., Gynec. & Obst., 1925, xl, 481–484.
2. Putnam, T. J., and Cushing, H. Chronic subdural hæmatoma; its pathology, its relation to pachymeningitis hæmorrhagica and its surgical treatment. Arch. Surg., 1925, xi, 329–393.
3. Rand, Carl W. Chronic subdural hæmatoma; report of seven cases. Arch. Surg., 1927, xiv, 1136–1165.

CONGENITAL DISLOCATION OF THE HIP

With Special Consideration of After-Treatment Following Closed Reduction[1]

WALTER I. GALLAND, A.B., M.D., New York
Assistant Attending Orthopedic Surgeon, Hospital for Joint Diseases; Assistant Orthopedic Surgeon, Lenox Hill Hospital

ORTHOPEDIC literature in recent years, particularly that emanating from American sources, has been extremely pessimistic in regard to the end-results of the closed reduction of congenital dislocations of the hip. Although from a number of foreign sources we have comparatively favorable reports, it would seem that many of our representative American orthopedic institutions are tending more and more toward favoring various open procedures for the alleviation of this condition. It is hard to reconcile such wide variations in results as reported by operators as competent as Putti and Lorenz abroad, with the thoroughly unsatisfactory results reported in this country.

The reduction of a congenital dislocation of the hip by the closed method is an operative procedure which requires considerable experience before thoroughly mastered in all of its details. The operation is not the more or less traumatic manipulative procedure as commonly pictured; in fact, the maneuvers must all be carried out gently and without the exertion of more force than is absolutely necessary to effect the reduction. The tender epiphyseal structures of the head of the femur and of the acetabulum are seriously injured by ill directed and violent forces falling upon these structures. Injury to the growing parts of the femoral head and of the acetabulum leads eventually to malformation of those structures and gradual development of re-luxation or incapacitating dystrophies of the hip.

In performing the reduction, certain anatomical and physiological considerations must be kept in mind. We are not only attempting to place the head of the femur in the acetabular area, but we are endeavoring to create circumstances conducive to the proper development of the ball and socket configuration of the normal joint. The main factor producing instability of the reduced joint is the shallowness of the acetabulum, and, unless we can create conditions which will favor the development of the acetabular socket, we can never hope to secure a stabile articulation. In the growth of the acetabulum, the most important single factor is the development of the upper and posterior margins of that structure. We must so reduce and maintain the femoral head as to avoid any direct contact between the head and these important margins of the acetabulum. The ideal position of reduction is that in which the head of the femur is withdrawn as far as possible from the superior, posterior margin of the socket, while still remaining well within the acetabulum, that is, the head should be reduced into the anterior inferior acetabular area. The accompanying X-ray films (Figure 1, A and B), illustrate hips which have been considered properly reduced by competent operators. Some of the films show contact of the head and the superior acetabular margin, which if continued, would surely prevent the development of the upper roof of the joint. In the films in which proper reduction is exhibited, it will be noted that the intimacy of this contact is avoided, and that any mechanical hindrance against the outward development of the acetabular roof is obviated. In this position too, the capsular pull favors the outward growth of the bone, to which it is attached at the upper margin of the joint (Figs. 2, 3, and 4).

In a way the plaster-of-Paris bandage, which is applied after the reduction of a congenital dislocation of the hip, is part of the after care. The original plaster bandage should be designed as far as possible to last throughout the primary period of immobilization. In applying the congenital hip spica, several important features in design should be kept in mind. It is absolutely essential that the spica should be permeable to the X-ray, particularly in the area over the hip joint; otherwise a clear visualization of the reduction will be impossible. It will be realized from the preceding discussion concerning the relationship between the head and the upper rim of the acetabulum, that it is essential, that a good X-ray film should be obtainable after operation. The use of metal reinforcing bands, commonly employed in some clinics, often defeats this prerequisite (Fig. 6). The application of too heavy a spica or the attempt to radiograph the joint in a wet plaster bandage will also impair the clear filming of the reduction.

It is desirable that the reduced extremity be permitted to function throughout the major portion of the period of immobilization, as it is mainly through function that proper growth influences

[1] From the Hospital for Joint Diseases, Service of Dr. Harry Finkelstein, and the Lenox Hill Hospital, Service of Dr. Charles H. Jaeger.

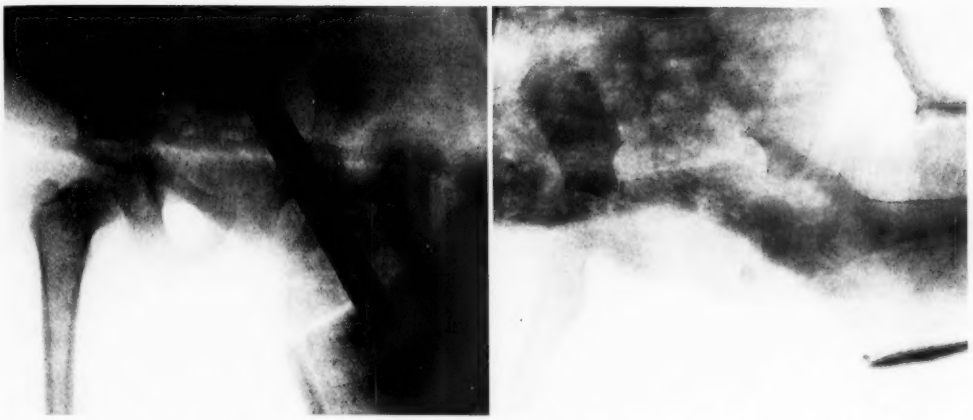


Fig. 1. A and B. Unilateral dislocation reduced, but an exaggeration of primary position would be preferable to avoid intimate contact present between the femoral head and the upper acetabular margin. Flexion should be accentuated.

can be imparted to the mal-developed head and acetabulum. With this thought in mind, the spica is applied so that it does not extend too high upon the chest and save in rare instances not below the knee. The spica should be accurately molded to the pelvic crests, and should reach no higher than the free margins of the ribs. Abduction of the thigh should never be carried out behind the frontal plane of the body, lest we induce an anterior luxation. The extent of flexion should be determined by the stability of the primary reduction. If, upon reduction, the superior and posterior rims of the acetabulum have been found to be unusually shallow, it is advisable to accentuate the flexion of the thigh in order to withdraw the head from the superior acetabular margin. This accentuated position is sometimes known as the axillary or Werndorff position. In the ordinary case, however, rectangular flexion is sufficient and is to be preferred. There is little doubt that the primary position is seldom actually maintained in the average bandage, and only too often does the X-ray picture show a thigh partially extended with the head of the femur, resting in close contact with the superior border of the acetabulum. Any such bandage should most certainly be immediately rectified, because the acetabulum is not prone to develop in the presence of this intimate contact between the acetabular margin and the femoral head.

In regard to the knee, the consideration of function is most important. Many operators are in the habit of including the knee in the congenital hip spica. This inclusion is seldom necessary and in most cases not desirable. In the first place, the constant maintenance of rectangular flexion of the knee favors contracture of the hamstring muscles, and the subsequent undue tension of these muscles when the leg is eventually extended upon the thigh at the conclusion of treatment, produces a force which may tend to cause a re-luxation. Indeed, it is most desirable at the time of operation thoroughly to stretch the hamstring muscles, and during the course of after-treatment while the child is in the primary spica to maintain the capacity to extend the leg fully upon the thigh, through the medium of active and passive exercises. If the knee has been included in the spica, such exercises cannot be carried out, and in addition it is difficult for these children to walk in such a spica, in which the knee has been included.

The question of permitting weight-bearing function of the reduced extremity while still in the primary bandage, is one about which there is a rather wide diversity of opinion, and perhaps a large number of failures can be attributed to the omission of this very important feature in the treatment. After the original reduction, and after it has been ascertained by X-ray examination that the femur has been thoroughly reduced, the child should be permitted to remain in bed for a period of from 3 to 4 weeks. During this period the parents must learn the principles of the adequate protection of the spica from soiling by urine and fæces. This can best be done by instructing the parents to draw flannel diapers through the cast posteriorly and thoroughly to diaper the pubic and perineal margins of the cast. In addition to this protection I have been accustomed to varnish the surface of the spica after it

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Figs. 2, 3, 4, 5. Unilateral dislocation in successive stages of treatment. Note the withdrawal of the head from the superior acetabular margin throughout treatment. Figure 4 was taken immediately after final removal of the spica and Figure 5 was taken approximately 2 years after the completion of the treatment. Note especially the development of the superior shelf of the acetabulum which has taken place.

has thoroughly dried. A coat of white Duco, which is a rapidly drying enamel-like paint, is a rather excellent waterproofing dressing.

At the end of 3 or 4 weeks in all cases except those in the exaggerated primary position, the child should be provided with a pair of shoes, the shoe upon the reduced side being so altered as to compensate approximately for the shortening produced by the abducted flexed position of the extremity. It is important that this compensation should not wholly equalize the length of the extremity, as there should be some pelvic tilt toward the dislocated side upon walking. The compensation can best be made by a thick cork sole added to the shoe. In the case of double congenital dislocations, it is self-evident that no compensation is necessary. When the shoe has been so provided, the child should be encouraged to walk, first aided by somebody holding its hands until the capacity for maintaining balance has been achieved. It is remarkable how quickly these children acquire the capacity to walk and

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 6. Bilateral congenital dislocation of the hips. The introduction of an opaque bar in the re-enforcement of the spica obscures the details of the reduction and makes an accurate diagnosis impossible. This case was pronounced reduced on the basis of the X-ray, but this assumption is unwarranted.

Fig. 7. Unilateral dislocation, in which an attempt was made to correct the primary position into a secondary position. It will be noted that re-dislocation has occurred.

Fig. 8. Unilateral dislocation showing the effect of the impingement of the femoral head upon the upper acetabular margin. Under the influence of this continued pressure, the tendency for acetabular development is very seriously impeded.

even to run, encumbered as they are by awkward spicas. Even patients with a double dislocation are able to learn to walk in the frog position.

The use of the extremity as outlined accomplishes a number of desirable things. It insures a healthy muscular development of the extremity, so that in place of atrophic and flabby musculature resulting from long cast confinement and inactivity, these children develop excellent tone in the muscular and ligamentous structures of the extremity. The function also prevents bony atrophy of disuse, and, if we are to place any confidence in the soundness of Wolff's law, also favors the development of the internal architecture of the femur and acetabulum along sound mechanical and architectural lines. It is not that the head of the femur is pounded into the acetabulum, as stated by many observers, but rather that stimulus is provided through use, affecting favorably the bony configuration and constitution of pelvis and femur. This element is an outstanding feature in the proper handling of these cases.

The congenital hip spica should be changed as infrequently as possible during the course of cast confinement. The frequent changing of the spica engenders re-dislocation, due to inadvertent manipulations of the extremity during the removal of the old spica and re-application of the new one. In any case, when the necessity for renewing the spica presents itself, it is best to carry out both removal and replacement of the spica under anæsthesia. If the spica has been well applied and if the parents are properly advised in regard to the protection of the spica and carry out such advice, renewal of the bandage will be an infrequent necessity.

In the average case, it is undesirable to resort to any but the primary position during the course of treatment. The use of secondary and tertiary positions, as formerly recommended, is to be avoided. This point should be emphasized. The entire course of treatment is carried out by means of only one position, that of the primary position of reduction. It is true that under certain circumstances this principle must be altered. Most important of these exceptions is the case of antetorsion of the head and neck of the femur, in the presence of which complication it is often desirable, after primary reduction, to apply a second spica in partial extension and exaggerated internal rotation of the thigh (Fig. 7).

During confinement in the spica X-ray pictures of the hip should be taken at intervals of 6 to 8 weeks. These films enable one to follow the progress of the development of the acetabulum, which is the most important single criterion by which the eventual stability of the reduction can be ascertained. If it is seen at any time during the course of treatment that the head is resting in close proximity to the superior acetabular margin, then the spica should be taken off, and the position so altered as to remove the head from this margin.

The duration of confinement in the primary position will vary to some extent according to the individual case. It is seldom, if ever, wise to make this confinement less than 6 months, and usually it is safer to overestimate the length of time, and

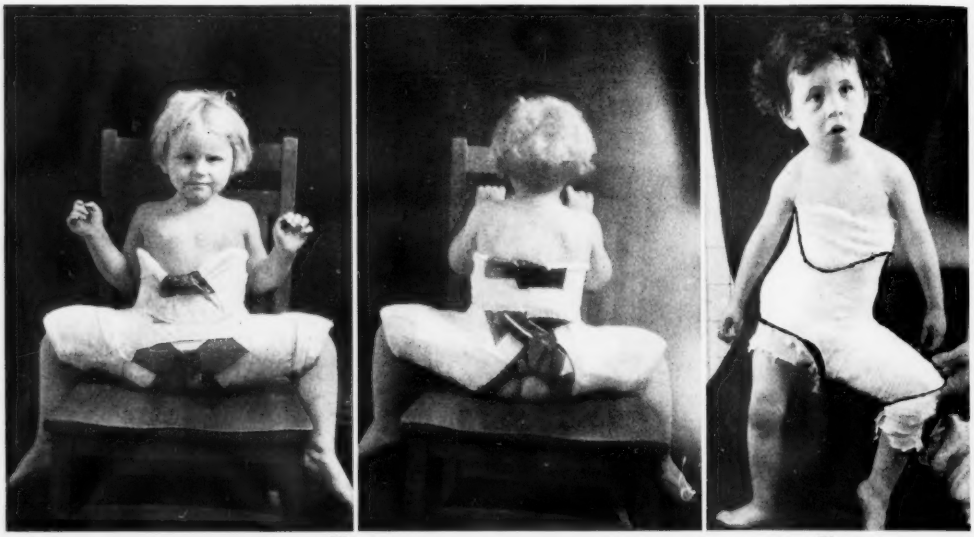


Fig. 9. Fig. 10.

Fig. 9. Reduced bilateral dislocation illustrating the position with the abducted thighs flexed somewhat above a right angle. Note the use of oil silk strips in order to protect the cast from soiling by urine and fæces.

Fig. 10. Unilateral dislocation of the hip before the cast has been fully finished. Note the low cutting of the plaster over the epigastrium. This permits abdominal respiratory movements and prevents interference with the digestive processes through the pressure of the cast upon the abdominal viscera. Note also that the knee is free.

to keep even the favorable cases in the primary spica for a period of from 7 to 8 months. It was formerly the universal custom to place the extremity in a secondary position in a plaster spica, by which the abduction and flexion were partially reduced. It is my experience that this is an undesirable procedure except in cases in which some complicating factor, such as antetorsion of the head, necessitates a secondary plaster in internal rotation. For the most part, after the period of primary immobilization has been passed, and reduction is evidently stabile in this position, the spica should be removed, and the child may be permitted to walk upon the extremity, wearing, in the case of unilateral dislocation, the raised shoe which has already been described. With this shoe the child will walk initially in an attitude resembling the primary position, as illustrated in the accompanying photograph (Fig. 11). We now resort to a method of gradual automatic correction of the flexion and abduction of the thigh, instead of any forcible correction of the extremity to parallelism. The raised sole of the shoe is gradually diminished in height from week to week, one-quarter of an inch being removed from the elevation every week or 10 days. Thus the child will very gradually bring the extremity down from the flexed position, and at the same time as the adductor muscles gain tone, will carry the thigh more and more toward the midline. By this very simple expedient an automatic correction of the flexed and abducted thigh is accomplished.

At the time when the spica is finally removed, a plaster shell is molded to serve as a night splint, in which the primary position is re-established during such times as the child may be recumbent. The preparation of this plaster shell is simple. The child is placed upon its face with the reduced thigh in the primary position. The skin of the back and of the thigh is well powdered with talcum, and a plaster shell is modelled by smoothly laying successive layers of plaster bandages from the level of the axillæ, including the thigh to the knee. This shell is well re-enforced and is built up to a thickness which will insure ample stability. When the plaster has dried, it is removed from the child, and after the edges have been trimmed down and bevelled, it is padded with a thin layer of felt which is best glued to the inner surface of the plaster. It is desirable but not necessary to place the shell in a wooden cradle, very much as a ship model is placed in a cradle, so that it will always rest upon an even keel. Fabric straps, and buckles to correspond, can be riveted to the edges

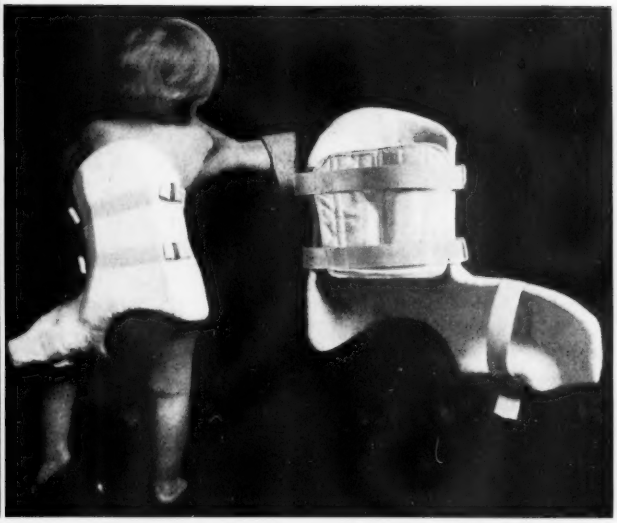


Fig. 11 (left). Unilateral dislocation illustrating use of raised shoe with cork sole in order to permit walking in the primary position during the course of treatment.

Fig. 12. Plaster night shell used in the after care in order to re-establish the primary position at night. The child is photographed in the standing position, so as to show the construction of the under surface of the shell, which is flattened in order to prevent rolling.

of the shell, so that the child can be secured in position, when placed therein. Of course, it is not necessary to elaborate the shell beyond placing a lining of sheet wadding therein, and in such a bed the child can be bandaged each night. The principle, however, which should be emphasized, is the necessity of re-establishing the primary position each night over a period which can most safely be estimated at a year from the time of the final removal of the plaster spica. This accomplishes several desirable things. It prevents the recurrence of muscular contractures, which would tend to produce re-luxation. It returns the head of the femur to the depths of the acetabulum for a period ranging from 8 to 12 hours daily, and thus favors a continuation of acetabular development, and by maintaining abduction and flexion, it prevents a too rapid correction of this position, which is most favorable to stability. There are other ways of maintaining this position at night, as for instance by means of a brace or by means of a split spica. However, the plaster shell is the least expensive, most comfortable, most controllable of devices.

A simple form of exercise is indicated in order to re-establish the muscular sufficiency of the reduced joint. Simplicity is desirable in order to enable the mother or a reasonably intelligent untrained nurse to supervise and control the exercises. We should be principally concerned with the development of the pelvi-trochanteric muscles, and at the same time aim actively to maintain the adductors and hamstrings in a functionally sufficient but thoroughly uncontracted condition. It must again be emphasized that abduction and abductibility favor stability, and for this reason we should devote the major attention to the development of the abductors of the thigh.

The exercises are best begun with the child lying upon its back, and active abduction is encouraged with only the frictional resistance of the surface upon which the extremity is lying. In very young children this active exercise may have to be stimulated by tickling the sole of the foot or gently prodding it with a pin. As the strength of the abductors increases, slight resistance should be made with the hand in order to increase the

actual resistance against the abductors. When the muscles have been sufficiently strengthened, the child should be placed upon the opposite side, and abduction exercises should be made with the force of gravity acting against the abducted extremity. The attendant, who is supervising the exercises, must take care that the excursion is consummated in the frontal plane or somewhat behind this plane, so that the joint is to some extent overstretched. The resistance to abduction should be gradually increased, as the muscles gain strength.

The contracture of the hamstring muscles should be prevented by active and passive extension exercises of the knee. These exercises are best combined with the abduction exercises with the aim of ultimately enabling the child fully to maintain the leg in complete extension upon the thigh, while consummating abduction of the thigh in the frontal plane, as previously described. The contraction of the adductor muscles is, of course, prevented by these abduction exercises. Intelligent and not too vigorous massage is always to be recommended, although the masseur is to be cautioned against any manipulative procedures upon the joint.

The proper after care of cases of congenital dislocation of the hip after manipulative reduction can be summarized rather briefly. First, and perhaps most important, is the permission of function in the primary spica after a short preliminary period of bedrest following the operation. Second, the maintenance of the primary position throughout the complete term of plaster confinement. Third, a system which insures the gradual automatic correction from the primary position to parallelism of the extremities, which is accomplished by a gradual diminution in the height of the raised sole of the shoe. Fourth, exercises. Fifth, night retention in a plaster shell, in order to maintain and retain the capacity fully to re-establish primary position of the hip.

It is not claimed even by the most enthusiastic proponents of the closed method of treatment of congenital dislocation of the hip that the results of this method are approximately 100 per cent successful. So many factors are involved in the pathology of this condition, and so much depends upon the co-operation of the parents and of the patient, that failure is unavoidable in a certain number of cases, but this would apply with equal force to almost any condition in the realm of surgical practice. Under the most exacting supervision, and providing treatment is begun sufficiently early, a large majority of patients will attain approximately anatomical and permanently stabile reduction. A certain number of cases, even if irreducible, can secure an improvement, if a posterior dislocation is transformed into an anterior dislocation. The results of this deliberately executed procedure are sometimes extremely useful, and are also excellent from a cosmetic point of view. There is little room for doubt that a more meticulous attitude toward the after care following reduction in cases of congenital dislocation of the hip will yield far more satisfactory end-results than are currently reported.

PRIMARY ADENOCARCINOMA ARISING IN A MECKEL'S DIVERTICULUM

PAUL MICHAEL, M.D., AND H. GLENN BELL, M.D., SAN FRANCISCO
From the Departments of Pathology and Surgery of the University of California Medical School, San Francisco

EVER since Meckel the younger described a diverticulum of the lower ileum in 1809, the medical literature has contained many articles describing this structure and its anomalies. The actual incidence of Meckel's diverticulum has been estimated to range from 1 per cent to 3 per cent of all individuals. Christie, in a very excellent review, ascertained the percentage to be approximately 1.1 per cent, and he gives the sex incidence as 75 per cent in males and 25 per cent in females. Harbin, in a less extensive series, determined that 35 per cent only were found in males and 65 per cent were found in females. Christie's figures are probably more accurate.

By far the greater number of complications have occurred in males. Cannon reported a double intussusception caused by Meckel's diverticulum; Coley described a diverticulum complicated by tuberculosis; McCalla cited a case of perforated "peptic ulcer" of Meckel's diverticulum. These complications are by no means isolated—they are merely examples of many kindred conditions. Though the foregoing complications are not uncommon, malignant neoplasms of Meckel's diverticulum are seen very rarely.

Many years elapsed between the original description of the diverticulum by Meckel and the first authentically reported case of malignant leiomyosarcoma by Fried, in 1902. Kaufman, in 1911, reported that, in the Basle collection, there existed a case of a spindle cell sarcoma of Meckel's diverticulum occurring in a woman 72 years of age. Later in the same year, Tschinknowerow described a case in which, at autopsy, a malignant spindle cell sarcoma was found in a woman 62 years of age. Haessner, in 1913, cited a malignant tumor adherent to and including a Meckel's diverticulum. This was probably also a spindle cell sarcoma and was in an advanced stage of degeneration. Douglas Symmers, in 1919, reported the second case of a malignant leiomyosarcoma, occurring in a male 22 years old. This tumor was found as an incidental feature in the course of an operation for hernia and apparently gave no symptoms. Black, also in 1919, made mention of a potentially malignant papillomatous growth arising in a diverticulum in the sigmoid region. The inclusion of this tumor as a neoplasm of Meckel's diverticulum has been questioned by most authors. In 1925, Crile reviewed the literature and added a case of spindle cell sarcoma occurring in a woman 41 years of age. This tumor was removed and the patient given a full course of deep X-ray therapy. One year later she gave no evidence of subsequent involvement or metastases. Mathews, in the same year, reported a very interesting case of a myoma, arising in Meckel's diverticulum, which was removed at operation in a woman 44 years old. Five years later the patient returned with a recurrence of the tumor and considerable pelvic involvement, histologically a malignant leiomyosarcoma. The first carcinoid tumor of Meckel's diverticulum was reported by Hicks and Kadinsky in 1922; this occurred in a boy 12 years old. In 1926, Stewart and Taylor noted a carcinoid tumor arising at the tip of a Meckel's diverticulum in a male patient 54 years of age. After careful examination of material from Hicks' and Kadinsky's patient, Stewart and Taylor questioned the correctness of the diagnosis of carcinoid tumor in this first case and considered it to be an instance of heterotopia of the gastric mucosa.

Thus we have found in the literature, 4 cases of spindle cell sarcomata, 3 cases of malignant leiomyosarcomata, 1 potentially malignant papillary tumor of a sigmoid diverticulum, and 2 cases of argentaffine carcinoid tumors. We submit the following case as that of a true malignant adenocarcinomatous tumor of Meckel's diverticulum:

R. W., white, American male, aged 67 years, carpenter, entered the University of California Hospital on December 19, 1930. The past history and family history were uneventful. Patient complained of vague indigestion, slight loss of weight (7 pounds in 7 weeks), weakness, vomiting, constipation, and severe intermittent abdominal cramps which had been present for about 10 weeks. The cramps were initiated in the lower left quadrant of the abdomen and traveled across to the right lower quadrant. Coincident with these pains he had distention, unrelieved by enemata. Massage of the abdomen caused the gas to move and gave some relief. Borborygmus was marked. Vomiting was induced for relief and the patient said that the vomitus contained food eaten 48 to 72 hours previously; there was no blood in the vomitus. For the past year he had been troubled by constipation as well as a change in the character of the stool from a soft, formed, to a hard, lumpy, dehydrated stool; there was no blood in the stool at any time. Castor oil gave relief from the constipation.

Physical examination showed a moderately emaciated man, whose skin was sallow and showed evidence of de-

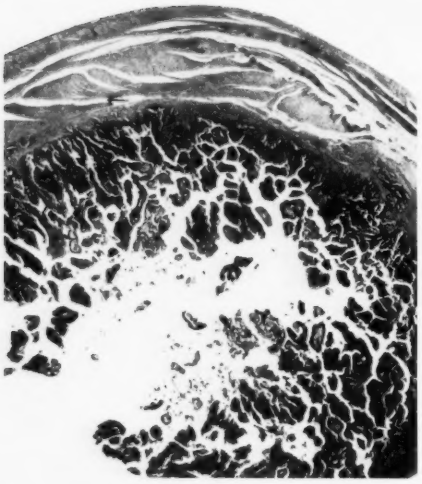


Fig. 1. Low power magnification showing carcinoma at the distal end of the diverticulum.

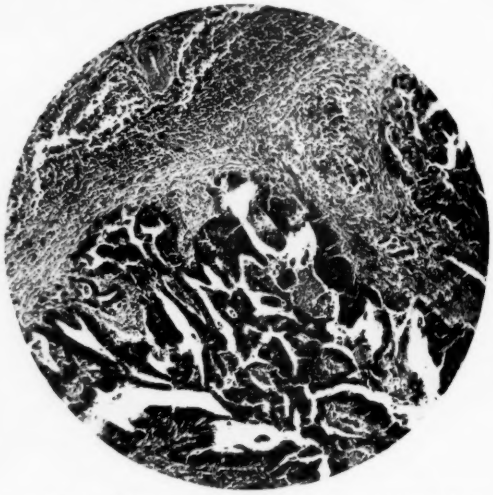


Fig. 2. High power magnification of carcinoma shown in Figure 1.

hydration, lying quietly in bed, not acutely ill. The general physical examination was essentially negative except for the abdomen. There was an indefinite mass in the lower right quadrant which was movable but not tender. There was considerable distention, and peristalsis was very active, yet definite peristaltic waves could not be seen. No other masses or organs were felt. The rectal examination was negative.

Laboratory examinations revealed a normal gastric acidity, negative Wassermann test, sedimentation time of 2 hours and 27 minutes, and a normal urinalysis. His blood count showed 55 per cent hæmoglobin (S); red cells, 4,550,000, white cells, 4,950; with a normal differential count. The stools were negative for blood. Roentgen-ray examination showed a suspicious process in the cardiac end, along the greater curvature of the stomach and a definite obstruction in the lower ileum.

Pre-operative diagnosis: stomach lesion with obstructive metastases to the ileum.

Operation. December 19, 1930. Under a combination of local and light gas-oxygen anæsthesia, an exploratory laparotomy was performed through a right rectus incision. The stomach and upper abdominal organs were closely examined and found to be normal. An annular constriction and a diverticulum of the ileum were found about 1 meter from the ileocæcal junction. No other masses or pathological changes were found. The proximal portion of the bowel was hypertrophied and dilated to twice the size of the distal portion. The muscular coat was greatly thickened. A segment of the ileum, including the diverticulum, was resected and a lateral intestinal anastomosis, no-clamp or Halstead method, was done, silk sutures being used throughout. A portion of the mesentery with the regional glands was removed also. An undigested grape was found in the ileum proximal to the constriction. The patient was given a transfusion of 500 cubic centimeters of whole blood at the time of operation.

His recovery was uneventful and he was up and around the ward from the third day after operation until his discharge from the hospital on the twelfth day after operation. Subsequent follow-up of the patient showed him to be free from symptoms.

Pathological report: The specimen submitted was a portion of the ileum 11 centimeters in length, removed at operation. It was said to be removed from the terminal ileum about 1 meter from the ileocæcal junction. There was a diverticulum, 2.5 centimeters in diameter and 3.5 centimeters in length, growing from the lateral wall. Cross section through the diverticulum presented a thickened wall, an injected serosa, and an ulcerated, swollen mucosa. The wall was composed of hard, indurated yellow tissue. On following the lumen of the diverticulum, it was seen to open into the lumen proper of the ileum. Growing out from the base of the diverticulum was an annular encircling band which completely surrounded the ileum and caused an obstruction. An intact grape was seen in the ileum proximal to the encircling band, causing an obturator type of obstruction. The proximal bowel was hypertrophied and dilated.

Microscopic examination: The microscopic section showed an arborescent, bizarre, immature, adenomatous growth involving the entire mucous membrane of the diverticulum and the ileum in the region of the annular constriction. The cells were rapidly-growing, hyperchromatic, and showed many mitotic figures. They were infiltrating and displayed no regard for the confines of the basement membrane, which had been invaded extensively. This cell pattern extended into the wall generally. The wall was thickened and there was an excess of fibrous tissue seen. The diverticulum contained all the coats of the small intestine, and there were a few lymphoid aggregations in the submucosa. The muscular layer showed small groups of round cells between the bundles. The serosa was thickened, engorged, and contained many collars of round cells arranged as perivascular infiltrations. The ileum above and below the constriction showed a normal microscopic picture, although the proximal wall of the ileum was hypertrophied. No glands involved.

Diagnosis: Adenocarcinoma of the ileum arising in a Meckel's diverticulum.

As an adenocarcinoma of Meckel's diverticulum is certainly one of the rarest of pathological curiosities, every effort was made to establish all the necessary requirements. The gross and microscopic pathological examinations clearly establish the diagnosis of adenocarcinoma. In Christie's series of cases, the average site of the diverticulum was found to be 1 meter from the ileocæcal junction. Von Schaetz found that usually the diverticula inclined orally. The diverticulum in our case fulfilled both of these requirements. Although it was antemesenteric, it was not diametrically opposite to the mesenteric attachment. The lumen was rotated about 6 degrees from this point, but this was caused by the distortion of the ileum by the annular growth which grew out from the base of the diverticulum and encircled the intestine. This requirement of antemesenteric position, however, need not be met in order to establish the diverticulum as a true Meckel's. Many authorities have reported true Meckel's diverticula which were not placed in the axis opposite the mesentery (2, 17, 18).

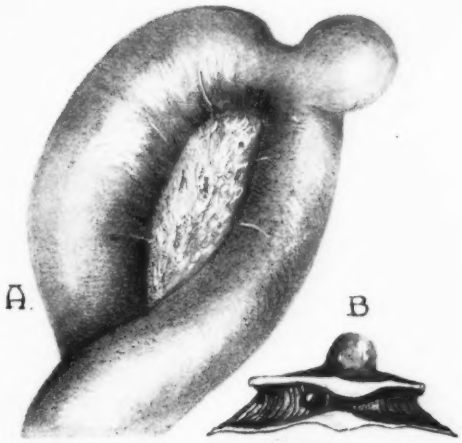


Fig. 3. A, Loop of ileum showing diverticulum and hypertrophied intestine proximal to the diverticulum. B, The lumen of the ileum exposed showing intact grape proximal to the constriction, causing a ball-valve obturator type of obstruction.

SUMMARY

A case of primary localized adenocarcinoma arising in Meckel's diverticulum, in a male 67 years of age, is presented. The growth was removed and a lateral intestinal anastomosis was done. To date the patient is free from any symptoms of intestinal obstruction or extension of the tumor. Previously there have been described and reported only 7 other neoplastic processes which were malignant; all were of the sarcomatous variety. A sedulous search of the literature reveals that this is the first case to be reported of a malignant adenocarcinoma of this type in a true Meckel's diverticulum.

REFERENCES

1. Black, W. T. Congenital diverticula of the intestines. Surg., Gynec. & Obst., 1919, xxviii, 473–477.
2. Cannon, D. J. Irish J. Med. Soc., 1928, i, 27.
3. Christie, A. U. Personal communication.
4. Coley, B. L. Arch. Surg., 1925, xi, 519–528.
5. Crile, George W. A primary spindle cell sarcoma of Meckel's. Surg., Gynec. & Obst., 1925, xli, 615–617.
6. Cullen, T. Z. The Umbilicus and its Diseases. Philadelphia: W. B. Saunders & Co., 1916, p. 162.
7. Fried, O. Ein Fall von primaeren Sarkom des Meckelschen Divertikels (Erlanger). Bambery, 1902.
8. Haessner, H. Zur Pathologie des Meckelschen Divertikels. Frankfurt. Ztschr. f. Path., 1913, xiv, 501–506.
9. Harbin, R. M. Surg., Gynec. & Obst., 1930, li, 863–870.
10. Hicks, J. A. B., and Kadinsky, S. Carcinoid tumor of Meckel's diverticulum. Lancet, 1922, ii, 70.
11. Kaufman, E. Lehrbuch der Speziellen pathologischen Anatomie, 6th ed., p. 465. Berlin.
12. King. Guy's Hosp. Rep., 1843.
13. Mathews, F. S. Meckel's diverticulum. A report of twelve cases, including one tumor. Arch. Surg., 1925, x, 720-729.
14. McCalla, A. I. Canadian M. Ass. J., 1927, xvii, 79–81.
15. Schaetz, George von. Beitrage zur Morphologie des Meckelachen Divertikels. Eingegangen ann., 1925, xix, Sept.
16. Stewart, M. J., and Taylor, Leeds, A. L. J. Path. & Bacteriol, 1926, xxix.
17. Symmers, D. The association of malignant myomata with Meckel's diverticulum. Ann. Surg., 1919, lxx, 183–187.
18. Tschinknowerow, L. Zur kenntnischer pathologischen Gewebsbildungen im Meckelschen Divertikel. Berl. klin. Wchnschr., 1911, ii, 1676–1679.

INJECTION TREATMENT OF VARICOSE VEINS

A Report of Three Hundred Twenty-Five Cases

CARNES WEEKS, M.D., and R. STERLING MUELLER, M.D., New York
From the First Surgical Division, Bellevue Hospital

So much has been written on the subject of the injection treatment of varicose veins that it will not be the purpose of this paper to review the literature. This method of treatment is now recognized as being the best one for ridding the patient of varicose veins of the lower extremities. True varicose ulcer and varicose eczema can also be adequately treated through the obliteration of the associated veins. The present report deals with the results obtained in 325 successive cases of varicose veins treated in the Clinic of the First Surgical Division of Bellevue Hospital from November 1, 1928, to September 1, 1930. Included in this paper is the report of a death from pulmonary embolus, following ligation of both internal saphenous veins.

Age incidence. Table I shows that 49.4 per cent of the patients were in the age period between 30 to 50 years. No patients under 20 years of age were treated. The oldest patient treated was 77 years of age.

Duration. The average duration of the varicose veins in these 325 cases was 11.4 years. The longest period of time a patient was afflicted was 40 years.

Sex. Of these cases, 225 were females and 100 were males—a ratio of over 2:1.

Reasons for treatment (Table II). Of the 325 patients, 60 per cent complained of various degrees of swelling; 65 per cent of pain; and 78 per cent of a tired feeling in the legs. Four and five-tenths per cent were treated because of recent hæmorrhage from superficial varices. Thirty patients, mostly women, were treated for cosmetic reasons; 6.5 per cent were young men seeking employment in the police, fire, and post office departments, who had previously been rejected because of varicose veins; and 5.9 per cent were treated because of recurrence following phlebectomy—the interval varying from 1½ to 30 years.

Two of the cases had had deep phlebitis 15 and 21 years ago, respectively, and were successfully treated; both showing a marked decrease in the swelling of the affected leg. Six cases had had superficial phlebitis—the shortest interval between the phlebitis and the injections being 1 year.

Varicose ulcers (Table III). Fifty-three, or 16.3 per cent, of the cases had open ulcers at the time of the injection. The average length of time these ulcers had existed before treatment was 6.2 years; the longest period 30 years and the shortest 1 week.

One of the characteristics of varicose ulcer is the tendency to reopen after healing. In a study to determine the longest period of time these ulcers remained healed before injection treatment, it was found that the average period of temporary healing by means of the various ointments, supportive bandages, and surgical procedures, was 4.5 months. Twenty-seven, or about 50 per cent of the ulcers, had never healed for any period of time. Forty-seven, that is 88.7 per cent, healed with injections; the average healing time being 6 weeks. All of the 6 remaining cases showed some improvement.

Sixty per cent of these cases returned to the follow-up clinic for observation. The longest period of observation to date is 27 months, the average 12 months. Four ulcers reopened, all of which had been treated with salt solution—a solution which we have since discarded as unsatisfactory. These ulcers were subsequently rehealed through the use of a quinine and urethane solution.

Let us mention here that a dry, sterile dressing with a compression bandage was the only supplementary form of treatment used for these ulcers. There were 4 cases in which Unna's paste bandages were required.

An obvious contention would be that many ulcers would heal with compression bandages alone. The majority of our patients, however, had been coming to the clinic for many years, undergoing the usual local treatment, combined with compression bandages, and the ulcers had healed for only short periods of time, if at all.

There is no question but that certain types of chronic leg ulcers are not amenable to this form of treatment. We have had to refuse to treat a small percentage of cases of extensive ulceration because of the lack of visible or palpable veins which could be injected. Some patients, however, with characteristic brawny œdema and no discernible veins were put to bed with the legs elevated. Within a week the œdema had subsided and the veins at fault could be injected. We have had 3 such cases, and have been successful in securing healing of the ulcer.

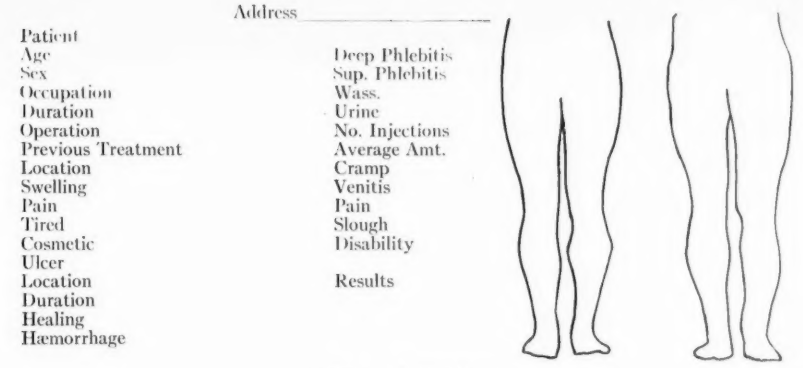


Fig. 1. History form.

This type of patient generally has large, dilated channels with thick walls, rather than the usual superficial thin walled varicosities. Many of these thick walled channels lie close to the ulcer, feeding its periphery, or, dipping beneath it, supplying its base. These channels, which can be felt only by deep palpation with a practiced hand, must be injected, if healing is to be obtained, even though the injection must be made through thickened, indurated tissue.

Eczema. Many of the patients complained of mild varicose eczema. There were 6 patients, however, whose chief complaint was severe eczema with marked itching. One patient (Fig. 9) had had this condition for 8 years with no relief for any period of time.

TABLE I.—AGE AND SEX INCIDENCE

	Cases
Under 20 years	0
20 to 30	54
30 to 40 years	72
40 to 50 years	88
50 to 60 years	72
60 to 70 years	36
70 to 80 years	3
Total	325
Females	225
Males	100
Total	325

TABLE II.—REASON FOR OPERATION

Symptoms	Cases	Per cent
Swelling	195	60
Pain	212	65
Tired	254	78
Hæmorrhage	15	4.5
Cosmetic	30	9.2
Job	25	6.5
Recurrence following operation	19	5.9

These 6 cases required an average of four injections apiece of quinine and urethane, and all were completely healed.

Phlebitis. We believe that a past history of deep phlebitis has been decidedly over emphasized as a contra-indication for injection. It has been stressed that injection is dangerous in these cases, as, due to the blocking of the deep channels, the superficial veins are very necessary. In our experience, however, we have encountered only one individual with a definite history of deep phlebitis

TABLE III.—VARICOSE ULCERS

Ulcers at time of injection. 53 cases; 16.3 per cent.
Average duration of ulcer, 6.2 years.
Average healing time, 4.5 months.
Ulcers that had never healed, 27, the ulcer being present from 1 week to 30 years.
Severe varicose eczema, 6 cases.
Phlebitis, superficial 6 cases, deep 3 cases.

TABLE IV.—FOLLOW-UP

Average time for healing of ulcer after treatment, 6 weeks.
Ulcer reopened in 4 cases.
Disability—325 patients lost 60 days from work.
Follow-up examinations were made in 200 cases, 61 per cent.
Recurrence of veins found in 15 cases, 4.6 per cent.
Ulcers returned in 29 cases of 53, or 55 per cent.
Ulcers healed in 47, 88.7 per cent.
Ulcers improved in 6.

TABLE V.—DATA ON INJECTIONS

Number of injections	1753
20 per cent sodium chloride	245
30 per cent sodium chloride	191
40 per cent sodium salicylate	483
Mixture	25
Quinine and urethane	806
Average number of injections	5.4
Sloughs	18

Average time required for treatment—3 weeks.

Fig. 2. Ulcer of the right leg. Duration 2 years. It had never healed. The large, tortuous vessel draining this area can be seen. Three injections of quinine and urethane. Follow-up of 6 months. Ulcer well healed and no varicose veins.

whose veins we were unwilling to inject. In this case we constricted the superficial veins with a tight compression bandage, and instructed the patient to walk a distance of several blocks. This walking resulted in extreme pain and cyanosis of the lower leg, which showed these superficial veins to be essential. Other patients with similar history were treated identically, and returned from the walk with a sense of added support in the leg. These were injected, with good results and a complete disappearance of swelling and pain.

On the other hand, numerous cases of recent superficial phlebitis associated with varicose veins have been refused treatment by us and instructed to return in 1 year—the shortest interval we feel to be compatible with safety. The danger of injection after too short an interval has been adequately substantiated by the fact that most of the few reported deaths following this treatment have occurred in such infected cases.

Fig. 3. Ulcer of the left leg for 18 years. The longest time it had healed was 2 months. The veins draining this area are deep channels and are not visible. Injections with quinine and urethane and follow-up 8 months later shows the ulcer well healed.

It might be well to mention here the death of a patient with a definite history of acute phlebitis 3 months before, which had confined her to bed for 1 month. She was referred to us for injection of her extensive varicose veins. Treatment was refused by us because of the danger of pulmonary embolus. She was admitted to the hospital, however, by another physician for ligation of both internal saphenous veins. After an uneventful 11 day postoperative course she was allowed up—and died within 2 hours, quite suddenly. Autopsy showed an embolus of the left branch of the pulmonary artery, with a thrombus formation about one inch in length above the ligature of the left

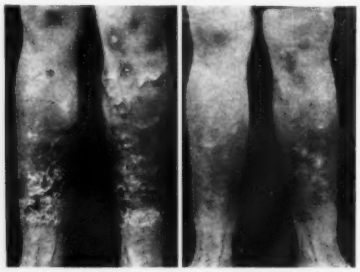


Fig. 4. Multiple ulcers of both legs. Duration 12 years. There had been no healing during this period. Wassermann repeatedly negative. Fifteen injections of quinine and urethane. Follow-up at 9 months shows the ulcers well healed.

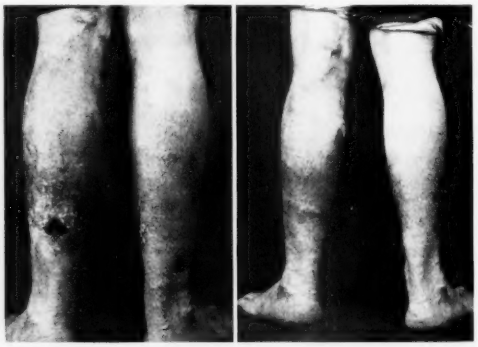


Fig. 5. Posterior view of Figure 4. Ulcer of left leg, duration 1 year. Injections with quinine and urethane and a 9 months' follow-up shows the ulcer healed. The outlines of the original veins are seen but are now firm and cordlike.

Fig. 6. Ulcer of the left leg. Duration 6 years. Never healed. Injections with quinine and urethane and 4 months' follow-up.

Fig. 7. Ulcer of the left medial malleolus. Duration 2 weeks. Injections with 40 per cent sodium salicylate and quinine and urethane. Fourteen months' follow-up.

internal saphenous vein. We feel that we cannot overemphasize the importance of the danger in injections and still more in saphenous ligations following a recent acute phlebitis, as the deaths from pulmonary embolus that have been reported following varicose vein injection have occurred usually in such cases.

If it was dangerous to inject such a case, it was many times more dangerous to ligate the saphenous veins.

Injections. A total of 1,753 injections were made in 325 patients—an average of 5.4 injections for each case. One patient with very extensive varicosities required 43 injections, though many cases required but a single treatment.

Twenty per cent sodium chloride was given 245 times and 30 per cent sodium chloride 191 times. This was the first solution used by us. Its use was abandoned, however, when we found that the veins became recanalized after a short interval. In many cases this solution, instead of forming a thrombus which entirely filled the lumen of the vessel, caused marked thickening of the vessel wall without obliteration, thus rendering further injections with other solutions more difficult. We did not find this to be the case with other solutions.

Forty per cent sodium salicylate was used 483 times. We find this an excellent sclerosing agent used in 5 cubic centimeter doses, with both ra-

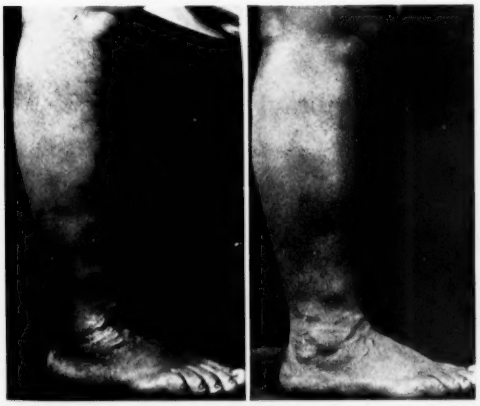


Fig. 8. Small ulcer of right external malleolus. Duration 8 months. Extremely painful. Injections with 40 per cent sodium salicylate. Photograph 4 months later. Follow-up of 1 year.

Fig. 9. Varicose eczema of the left leg. Duration 8 years. No healing at any time and intense itching. One large vein seen. Four injections of 40 per cent sodium salicylate. Photograph 3 months later with relief of condition. Follow-up 1 year.

Fig. 10.

Fig. 10. Recurrent varicose veins along the scar of the previous operation. Phlebectomy done 8 years before. Injections of 40 per cent sodium salicylate and quinine and urethane. Photograph 2 months later. Follow-up 7 months.

Fig. 11.

Fig. 11. Photograph 1 month after 5 injections of quinine and urethane. Follow-up 1 year.

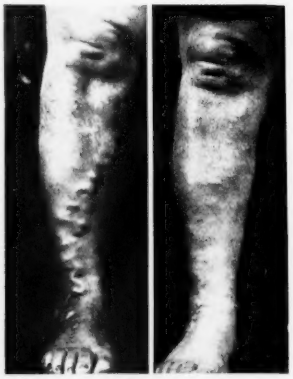


Fig. 12.

Fig. 12. Three months after injections of 40 per cent sodium salicylate.

pidity and sureness of action. Its one great disadvantage is the great severity of the cramp which accompanies its use—more severe than with the use of any other solution. A mild systemic reaction, accompanied by dizziness and a general feeling of malaise, is not uncommon. One woman developed a rather marked skin eruption with swelling of face, lips, tongue, and hands, which subsided after 3 days.

A mixture of 50 per cent dextrose and 30 per cent sodium chloride was used twenty-five times, but the results obtained with it were similar to those obtained with hypertonic sodium chloride.

Quinine and urethane in 2 cubic centimeter doses has been used 806 times, and has become very definitely the solution of choice. Some people are sensitive to quinine, however, and previous to injection such a history may be elicited. An immediate coryza with coughing and sneezing is occasionally seen, but usually lasts but a short time.

Sloughs. One of the most unpleasant complications of the injection treatment is the occasional occurrence of sloughs. For the most part, however, their occurrence is due to an error in technique, i.e., either a perivascular injection is made, or leakage occurs after the withdrawal of the needle. A novice, therefore, in learning to give the treatment is quite likely to have this occur. Obviously, in a teaching clinic, where internes are being trained in this procedure, the percentage of sloughs is inevitably comparatively high. This accounts for the large number of sloughs in our series, as, during the past year but two small sloughs have been caused by ourselves.

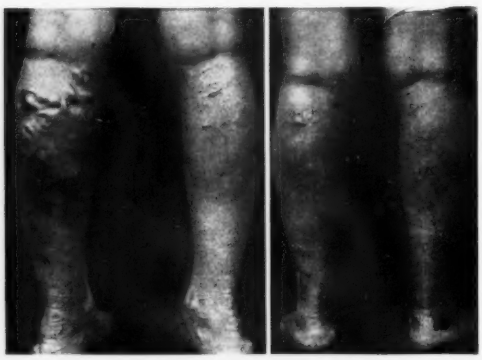


Fig. 13. Six weeks after 6 injections of quinine and urethane.

Fig. 14. Nine months after injections of sodium salicylate and quinine and urethane.

Fig. 15. Four months after 7 injections of 40 per cent sodium salicylate and 3 of quinine and urethane.

Fig. 16. Three months after 3 injections of quinine and urethane and 3 of 40 per cent sodium salicylate. Note the appearance of enlarged veins of the right leg in the later photograph.

In all we had 18 sloughs. Most of these were less than 1 centimeter in size, and caused very little trouble or pain to the patient. No large sloughs requiring surgical excisions occurred. The greatest number developed after the use of salt solution, while only 3 occurred after injections of the quinine and urethane.

The average healing time for the sloughs in our series was 11 weeks. The ordinary slough, after the surrounding inflammation has subsided, is non-painful and is best treated with bland ointments. Later, when the slough has separated and granulations are appearing, a stimulating ointment is required.

Perivenitis. The perivenitis, which is so apt to occur following the injection of large veins, we believe insures an excellent obliteration. The area involved is red, tender, and sometimes swollen. This condition usually subsides within 3 to 4 days and in very few cases will it be so severe as to require rest and wet dressings. We have found that a stronger reaction results from salicylate than any other solution.

Disability. We have attempted to discover as accurately as possible the amount of time in days lost from work by the patients, due to pain and discomfort, and we have found that in the 325 individuals the total number of days lost from work was 60. The shortest time lost was 1 day, and the longest 2 weeks. The latter patient was suffering from a slough which occurred in the early days of our experience. These 60 days are all in marked contrast to the 6,825 days which would necessarily be lost by an equal number of patients undergoing phlebectomy—allowing only for the 21 days in bed after operation, let alone convalescence.

There has been in our series no mortality, no case of infection, and no other unpleasant complication beside the recorded sloughs.

Time for treatment. The average time required for obliteration of the offending veins was 3 weeks.

TECHNIQUE OF INJECTION

When the patient is first admitted, a history form, as shown in Figure 1 is filled out, and the

Fig. 17. Five and one half months after 6 injections of quinine and urethane.

offending veins and ulcer, if present, are marked on the diagram. A physical examination is done only in those cases in which a cardiac or nephritic condition is suspected. Wassermann tests are made on all ulcer cases, and photographs are taken both before injection and after a follow-up of 6 months.

We prefer to treat varicose veins associated with pregnancy with supportive bandages rather than to run the risk of abortion—a very probable sequence of repeated injections of quinine and urethane or salicylate. We also find it inadvisable to inject veins during the first few days of menstruation, as it usually increases dysmenorrhœa and its accompanying symptoms.

We believe that in a large clinic, the simpler the technique, the better the results.

A 5 cubic centimeter hypodermic syringe is used. It is important that the needle be sharp, short beveled, and of small bore.

As the current of blood, in the majority of cases, is from above downward, we find that the most satisfactory point for the first injection is in one of the proximal groups of veins.

Patients who have small or medium sized veins are injected while standing, then placed in a horizontal position for 5 minutes. Those patients whose veins are large are usually injected while prone, to obtain the collapse of the veins, so that the fluid may exert its maximum effect on the endothelium of the vein without too much dilution. In each case, the needle is left *in situ* for 2 to 3 minutes to enable the injected fluid to work on the intima of the loop injected. After its withdrawal, to prevent leakage, firm pressure is exerted at the site of injection. Whenever there is any suspicion of such leakage outside of the vein, however, 5 to 10 cubic centimeters of normal saline solution is injected about the site of the original injection. If pressure is applied too early, the sclerosing agent is diffused too rapidly.

Follow-up. Of 325 patients treated, 200, or approximately 61 per cent, returned for follow-up examination. The period of time elapsing ranges from 1 to 27 months. Fifteen of these patients had developed a recanalization of the injected veins. These were all cases, as previously stated, which had been injected with 20 per cent or 30 per cent salt solutions. We have seen no such recurrence following salicylate or quinine and urethane injections. Eight cases needed further treatment simply because small veins had not been treated and had dilated in the interim.

CONCLUSIONS

1. The injection treatment is the safest and surest method of ridding the patient of varicose veins. No mortality should occur if cases suffering from recent superficial phlebitis are excluded.

2. This is an effective method of treating varicose ulcer and varicose eczema. In our series, 88 per cent of such cases were healed, and remained so, according to our follow-up observations.

3. The technique should be simple, and single injections at each treatment should be given.

4. Quinine and urethane is our solution of choice because of sureness of results and absence of cramp. Forty per cent salicylate is also a splendid sclerosing agent, but severe cramp accompanies its use. We find 20 to 30 per cent salt and dextrose and saline mixtures unsatisfactory solutions for injections, as they are more apt to cause sloughs and, too, they account for the entire number of recurrences noted at follow-up.

THE NECESSITY FOR BRONCHOSCOPIC EXAMINATION IN DISTINGUISHING PRIMARY CARCINOMA OF THE BRONCHUS FROM SUPPURATIVE DISEASE OF THE LUNGS

PORTER P. VINSON, M.D., F.A.C.S., ROCHESTER, MINNESOTA
Division of Medicine, The Mayo Clinic

OBSTRUCTION of the bronchus is almost always followed by suppurative disease of the lung. When the obstruction is removed, the rapidity of resolution of an inflammatory pulmonary process is remarkable. This is strikingly illustrated in case of foreign body in the air passages where suppurative processes begin soon after aspiration has occurred and usually resolve with great rapidity after the foreign body has been removed even though it has been present in the lung for months or years. When one remembers the fact that primary malignant disease in the lung usually begins in a bronchus and produces bronchial obstruction, it is not strange that the symptoms of primary bronchial carcinoma should resemble those of pulmonary abscess, bronchiectasis, or empyema.

In a recent review of 71 cases of bronchial carcinoma, proved by tissue removed from the bronchus at bronchoscopic examination, I was greatly impressed with the fact that in many cases the clinical and laboratory evidence suggested that the lesion was inflammatory only.

It is, of course, quite impossible to distinguish carcinoma of the bronchus from an inflammatory lesion in the lung or pleura by the history or by general examination; roentgenoscopic examination in 23 cases showed evidence of abscess or bronchiectasis only. Fever was present in more than half of the cases (38) and the leucocytes numbered more than 10,000 in 31 cases. The highest leucocyte count was 22,500.

There is no better method of making a positive diagnosis of primary bronchial carcinoma than by removing a specimen of tissue through a bronchoscope from a bronchial lesion. Even in the presence of metastasis to the cervical or axillary lymph nodes, bronchoscopic removal of tissue from a bronchus is preferable to the surgical removal of a lymph node for examination.

In many instances, an inflammatory bronchial lesion may have the gross appearance of carcinoma; the reverse is true also. Therefore, one should remove tissue for examination from every bronchial lesion if malignant disease is suspected and I may add that carcinoma of the bronchus should be suspected whenever the bronchial wall is infiltrated.

It has become almost a routine procedure in The Mayo Clinic to subject to a bronchoscopic examination every patient with cough and expectoration or pulmonary hæmorrhage, if the usual methods of examination have failed to reveal the presence of tuberculous disease in the lungs. Failure to adhere to this procedure will result in delay in diagnosis and misdirected surgical treatment.

For the purpose of illustrating some of the difficulties involved in the diagnosis of carcinoma of the bronchus, I am presenting the following cases:

CASE 1. A man, aged 30 years, came to the clinic July 25, 1928. He had been well until April, 1928, when an acute cold developed with cough, chills, fever, loss of weight and strength, and the expectoration of sputum streaked with blood. About 3 weeks before admission to the clinic, his condition became worse and there was considerable dyspnœa and pain in the left side of the thorax. July 6, a portion of a rib was resected elsewhere. Needles were inserted into the lung but fluid was not obtained.

Examination revealed diffuse infiltration in the lower lobe of the left lung with evidence of thickening of the pleura (Fig. 1). The temperature ranged from 101 to 102 degrees F. and the leucocytes numbered 17,000 to 18,000. The left side of the thorax was aspirated at four points around the scar of the previous operation, with negative results. August 7, a bronchoscopic examination was made and an infiltrating, ulcerating lesion was found in the bronchus to the lower lobe of the left lung. A specimen of tissue was removed for microscopic examination and proved to be a squamous cell epithelioma, graded 4. The patient died at his home in December, 1928. Postmortem examination revealed malignant disease throughout the left lung without any evidence of metastasis.

CASE 2. A man, aged 57 years, came for examination July 11, 1930. Since the age of 10 years, he had had a cough, expectorating a moderate amount of sputum. At the age of 17 this was associated with considerable pain in the thorax particularly on the left side. At the age of 30 years, the pain in the thorax disappeared but the cough persisted. Four months before admission to the clinic, he had contracted a severe cold, which was accompanied by fever and a daily chill. He was observed in a sanatorium for about 3 months and after pus had been aspirated from the right pleural cavity a diagnosis was made of empyema on the right side.

The patient was thin and pale and had lost 20 pounds in weight. Examination of the thorax revealed dullness, absent breath sounds, and absent vocal fremitus over the

Fig. 1. Diffuse infiltration in the lower lobe of the left lung with displacement of the heart to the right side.

Fig. 2. Increased density in the lower lobe of the right lung with evidence of interlobar pleurisy.

Fig. 3. Infiltration in the lower lobes of both lungs may be noted.

base of the right lung. Roentgenograms disclosed infiltration in the right cardiophrenic angle with pleuritic thickening and evidence of interlobar pleurisy at the level of the fourth rib anteriorly (Fig. 2). It was suggested that the process might be due to malignant disease. Leucocytes numbered 14,000 to 17,000, and mild secondary anæmia was present. The patient was quite hoarse, and examination of the larynx revealed swelling and redness of the left false vocal cord. It was thought that the lesion in the larynx was possibly tuberculous. The sputum was examined for the bacillus of tuberculosis, with negative results. July 16, the right pleural cavity was aspirated and 5 cubic centimeters of pus was withdrawn. Cultures were made from this, with negative results. July 19, 6 centimeters of the eighth rib on the right side was resected and the visceral and parietal pleura were found to be adherent. The lung beneath was firm and contained many small abscesses. A finger was inserted through the tissue of the lung, thus breaking into a number of these abscesses in an effort to promote drainage.

The postoperative convalescence was satisfactory and after a month in hospital, the patient was permitted to return home for a few weeks. When he returned for reexamination October 16, 1930, it was found that he had lost weight and strength and appeared much weaker than should have been the case if a draining pulmonary abscess were the sole cause of his disability.

Bronchoscopic examination, October 20, disclosed an ulcerated lesion in the right main bronchus. Tissue was removed for microscopic study and squamous cell epithelioma, graded 4, was found. The patient died at his home February 1, 1931. A postmortem examination was not made.

Case 3. A man, aged 61 years, came to the clinic September 1, 1927. He had had an attack of pneumonia

Fig. 4. Extensive pleural thickening on the right side may be noted. This is apparently associated with effusion.

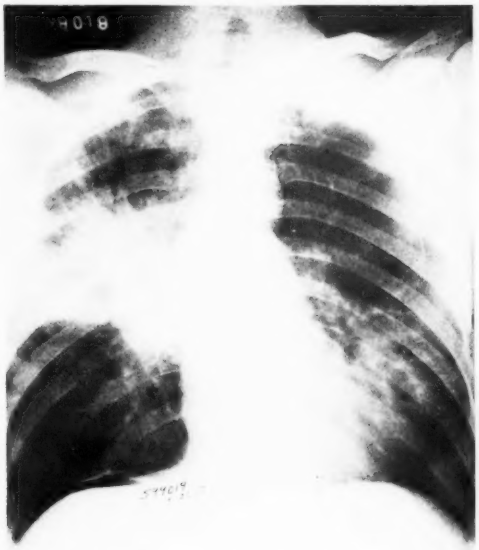


Fig. 5. Infiltration in the upper lobe of the right lung, apparently an abscess, with bronchiectasis at the base of the left lung.

in 1924 from which he had recovered completely. A second attack began March 8, 1927, and he was acutely ill for 9 weeks. Following this, there was continuous fever, pain in the right side of the thorax, cough, and expectoration. A diagnosis had been made elsewhere of pulmonary abscess, and bronchoscopic drainage was attempted without benefit. Lipiodol was injected into the lung and the patient was informed that a cavity was seen.

Examination disclosed infiltration in the base of the right lung with evidence of a pulmonary abscess and probably empyema. There was moderate secondary anæmia; leucocytes numbered 21,000. Roentgenograms of the thorax disclosed an abscess in the lower lobe of the right lung with areas of bronchiectasis in the lower lobes of both lungs and thickening of the pleura on the left side (Fig. 3). Bronchoscopic examination disclosed an ulcerating lesion occluding the lumen on the bronchus to the lower lobe of the right lung and tissue removed for examination was reported to be squamous cell epithelioma, graded 3. Roentgen therapy was carried out at the patient's home in conjunction with radium introduced through a bronchoscope directly into the growth. Marked temporary improvement followed this treatment with a gain of 40 pounds in weight. The patient is still living; his health apparently is failing.

Case 4. A man, aged 47 years, was admitted to the clinic May 15, 1929. He had been well until February 1, 1929, when his temperature rose to 103.5 degrees F. After the fever had persisted for 2 weeks without other symptoms, it was decided that numerous abscessed teeth were responsible for it and they were extracted. For a week after this, the patient was free from fever; it then recurred and when he came to the clinic the temperature was 102 degrees F. He had lost 60 pounds in weight and his strength was correspondingly reduced.

Examination disclosed a moderate amount of dyspnœa but no other pulmonary symptoms. Marked dullness to flatness of the percussion note was observed on the right side of the thorax below the second rib anteriorly with a diminution in breath sounds and absent vocal fremitus over the same area. A small lymph node was found in the right axilla. There was moderate secondary anæmia; the leucocytes numbered 11,500. Roentgenograms of the thorax revealed thickening of the pleura with fluid on the right side (Fig. 4). Because of the insidious onset of the illness, the diagnosis of malignant disease in the lung was considered, but it was thought advisable to perform diagnostic thoracentesis.

May 18, 1929, the right pleural cavity was aspirated and 1,800 cubic centimeters of thick creamy greenish pus was withdrawn; a catheter was inserted for further irrigation of the cavity. Culture of the pus showed the presence of diplococcus pneumoniæ (type II). An inflammatory type of lymph node was removed from the right axillary region. After a month of treatment the patient was permitted to return home until August 20, 1929. Shortly after leaving the clinic, he began to cough and to expectorate blood stained sputum; on one occasion, he spat up about 15 cubic centimeters of blood. When he returned for re-examination, it was decided to perform an open operation on the empyema cavity and this was done August 24, with the resection of two ribs. Following this, the cavity became progressively smaller, but in spite of satisfactory improvement in the local lesion, the patient's general condition became worse. December 11, bronchoscopic examination revealed an extensive epithelioma completely occluding the lumen of the right main bronchus. Tissue was removed for microscopic examination which revealed squamous cell epithelioma, graded 4. Deep roentgen-ray treatment was instituted but the patient died

at his home March 18, 1930. Postmortem examination was not made.

CASE 5. A man, aged 44 years, was examined May 27, 1927. He had been well until 4 years previously when he contracted a cold which was followed by continuous cough associated with expectoration of profuse amounts of purulent sputum. He had lost 30 pounds in weight and was growing progressively weaker. After a diagnosis of abscess in the upper lobe of the right lung an attempt had been made, elsewhere, to collapse the lung by injecting air into the pleural cavity. This resulted in partial collapse only, without any beneficial results.

At the clinic, roentgenoscopic and clinical diagnosis was made of bilateral bronchiectasis with an abscess in the upper lobe of the right lung (Fig. 5). The leucocytes numbered 22,500 and there was a low grade fever. Bronchoscopic examination disclosed a moderate degree of bronchiectasis on the left side and an abscess at the base of the upper lobe of the right lung, which was thoroughly aspirated. Following this treatment, the patient seemed somewhat improved. A second bronchoscopic examination was made 9 days later and tissue was removed from a granular lesion in the bronchus to the upper lobe of the right lung. This proved to be a squamous cell epithelioma, graded 4.

Treatment by roentgen-rays was administered at the clinic and at the patient's home. There was considerable temporary improvement in his general condition, but death occurred a year later. Postmortem examination was not made.

THE PELVIC DIAPHRAGM IN THE FEMALE—ITS FORM, FUNCTION AND A METHOD OF REPAIR FOR LACERATION[1]

HOWARD HILL, M.D., F.A.C.S., AND DWIGHT T. VAN DEL, M.D., KANSAS CITY, MISSOURI

THE female pelvic diaphragm is of such great importance in the function of childbearing and its attendant after-results that, for the past century, it has merited the attention of the anatomist and the surgeon. Numerous descriptions have been written concerning the anatomy of this region, but since artefacts due to parturition have not been recognized, many of them have been incorrect. In order to appreciate the significance of the pelvic diaphragm, a review of its development is not amiss.

In the process of evolution, Nature has made a series of physiological experiments, and the results are combined in the present day types which have survived. In the dog-fish, *Scyllium canicula*, the pelvic girdle is a transverse bar of cartilage placed anterior to the cloaca, and it is connected to the vertebral column by a portion of the lateral trunk musculature which extends forward from the tail into the body. Where this muscle passes over the pelvic bar, a portion of the lowermost fibers are attached to this cartilage. This strand of muscle fibers, of the ventral tail musculature, runs from behind, forward to the pelvic bar, and is called the caudopelvic muscle. Behind the cloaca, the caudopelvic strand borders upon its fellow of the opposite side and as the pelvic bar is approached, these strands diverge somewhat to surround the cloacal opening. Thus in fishes, a pelvic diaphragm scarcely exists.

Evolution of the pelvis has proceeded further in the amphibia. The ileum in the salamander is articulated to the rib of the single sacral vertebra, thereby making possible a to and fro movement upon the spine. In the menobranchus there is no sphincter cloacæ; however, since the animal is entirely aquatic, the absence of this muscle is easily understood. The salamander is terrestrial and in this animal the sphincter cloacæ is absent. The lack of a sphincter muscle is explained by the presence of the well developed caudopelvic muscles. These muscles arise in the median line of the tail, and they insert on the pelvic plate in such a manner that their inner borders are in apposition. When they contract synchronously, the pelvic plate is fixed by the recti, and the cloaca is bilaterally compressed, thereby occluding its opening.

In reptilia, sacral vertebræ appear which are bound together by fibrous tissue. The pelvis is completed inferiorly by the articulation of the ischial and pubic bones, which form a median symphysis. The caudopelvic muscles are well developed in the lizards; namely, iguana. Instead of a single muscle, as in some of the lower vertebrates, two well developed caudopelvic muscles are present. These muscles arise in the tail from an extensive origin, and as they extend forward they rapidly diminish in size, giving rise to a tendon which is inserted on the ventrolateral aspect of the pubis. As these muscles travel forward, the cloaca is situated between their medial borders.

A comparison of the anatomical conditions in reptiles, such as salamander and iguana, combined with a study of their mode of life, indicates that the evolution in structure is caused by an increase in general activity and change in respiration. The crocodile presents more advanced structures than in iguana. The caudopelvic muscles are poorly

[1]Presented before the Western Surgical Association, Kansas City, Missouri, December 5 and 6, 1930.

developed and their function in part has disappeared since the pelvis in the crocodile is completely ankylosed to the spine. These muscles exist only for a pressure effect on the pelvic cavity and cloaca, as they are inserted very close to the midline of the pelvis. Hence a review of the increasing complexity in the mode of life, from fishes to reptiles, indicates that the muscles which close the pelvic outlet are maintained for the most part wholly for a pressure effect.

In the great majority of terrestrial mammals, three pairs of muscles, connecting the pelvis with the tail, form an efficient closure of the pelvis. These muscles, which in the lower vertebrates were named the caudopelvic strand, are now designated as the pubo-ilio and ischiococcygeus muscles. In pronograde primates these pelvic floor muscles exist as well developed muscular sheets placed in two layers on each side of the pelvic cavity. The inner layer consists of the iliococcygeus and pubococcygeus, which in man form the levator ani muscle. The outer layer, or ischiococcygeus, represents the coccygeus muscle of human anatomy.

The iliococcygeus and pubococcygeus form a continuous sheet, the posterior margin of the one being contiguous with the anterior margin of the other. The pelvic line of attachment extends along the internal aspect of the pubic symphysis in the whole of its extent, and along the iliopectineal line as far dorsally as the spine of the ischium. The fibers converge from this wide origin and they pass backward and upward to be inserted into the ventral midline of the root of the tail. The iliococcygeus at its insertion ends in a fascial strand placed lateral to the pubococcygeus muscle. These two muscular sheets together, one on each side, form a funnel shaped closure of the pelvis from the abdominal cavity to the perineal region. At their origin and insertion the iliococcygeus and pubococcygeus muscles are attached to the midline and are in apposition with each other. Throughout their course they are separated only by the rectum and urogenital passages, which leave the pelvic cavity by passing between them. Toward the outer side of the previously mentioned muscular layer is the ischiococcygeus muscle, the thickness of which varies in different species. It arises from the ischial spine and is inserted into the lateral aspect of the tail root.

In the pronograde mammals, the pelvic floor muscles have been described as arising from the pelvis and being inserted onto the coccygeal vertebræ. On the other hand, in fishes, amphibians, and reptiles the caudopelvic muscles originate in the tail and are inserted in the pelvis. This difference is due to the fact that the proximal portion of the tail, in non-mammalian vertebrates, is rigid in the dorsoventral plane, being only freely movable from side to side, while the pelvis, excepting in the crocodillia, moves to and fro upon the sacrum. However, the tail when present in pronograde mammals is movable in all directions and the pelvis is fixed by bony ankylosis to the spine. Hence, in mammals these muscles should be described as arising from the pelvis, since that is the more stationary point.

There is a point of significance in the method of insertion of these muscles in the mammalian and non-mammalian vertebrates. In fishes, tailed amphibians, and reptiles, the caudopelvic muscles are attached to the tail at a considerable distance from the pelvis, and they are nearly in the same straight line as the recti muscles. Thus, the caudopelvic muscles appose the pull of the recti; in other words, the two groups of muscles acting synchronously, fix the movable pelvis. However, in pronograde mammals, such as primates, where the pelvis is permanently fixed, the attachment of the caudopelvic muscles has moved forward to the tail root, so that instead of being in the same straight line as the recti muscles, they are at right angles to them.

By some writers the pelvic floor muscles are considered to function as tail-moving muscles. However, in the ungulates which have a freely movable tail, the pubococcygeus and iliococcygeus are lacking while in the carnivora, in which the tail is movable, these muscles are present. Therefore, efficient movement of the tail does not depend on the presence of pubococcygeus and iliococcygeus muscles, since this movement occurs in their absence. Furthermore, a well developed ischiococcygeus muscle is present in carnivora and ungulates, but it has no effect on the distal and most movable part of the tail.

Since, in the tailed mammals, the pelvic floor muscles are said to be tail-moving in function, it is assumed that with the degeneration of the tail, these muscles have also deteriorated. In man the tail has degenerated, therefore, it is assumed that the homologues of these muscles have also shared in the degenerative process. The theory is good but the assumption is fallacious. In man the representatives of the true tail-moving muscles, namely the sacrococcygei, have degenerated with the coincident loss of the tail, while the pelvic floor muscles, although considerably changed, are markedly developed. By a study of the evolution of these pelvic floor muscles in fishes, amphibians, and reptiles, it is seen that their function is not to

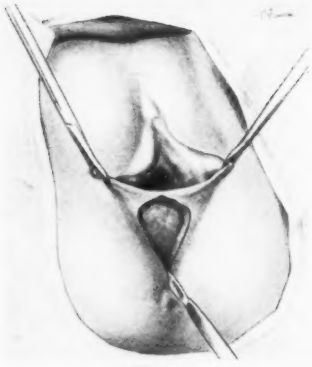


Fig. 1.

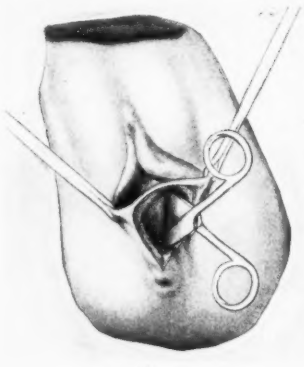


Fig. 2.

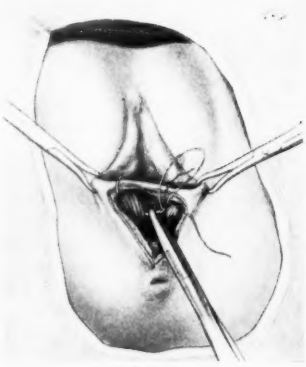


Fig. 3.

Fig. 1. Tenaculæ applied to the lateral mucocutaneous junction of the vagina. Tenaculæ pulled forward and upward making the perineum tense. Skin incision in the midportion.

Fig. 2. Left tenaculum pulled forward and outward. Closed scissors inserted into the loose connective tissue space between the vaginal wall and the fascia covering the levator muscle. Similar procedure carried out on the opposite side.

Fig. 3. Needle passed through the left levator muscle, and the needle is now seen entering the right levator muscle.

move the tail, but to fix the pelvis, and to function in the production and maintenance of normal visceral pressure. In mammals these muscles have the same action, and in man, even though the tail has degenerated, they function perfectly. However, in tailed mammals these muscles maintain increased visceral pressure in one of two ways, either by drawing the root of the tail against the perineum, or when the tail is held in extension by the dorsal sacrococcygei, they simultaneously increase their contraction.

Until the pelvis, in the process of evolution, becomes firmly fixed, the muscular arrangement as it occurs in fishes, reptiles, and amphibians appears logical. However, the real reason for such an adjustment appears, when the pelvis becomes fixed, and especially is this true in man with the assumption of the upright position. At this time, these muscles cross the pelvic outlet in the shortest route possible, occlude the pelvic outlet, and play a part in the maintenance of visceral pressure. Thus, throughout the evolution of mammals we find that the pelvic floor muscles are not degenerated tail-moving muscles, and that these muscles exist for the production and maintenance of a frequently recurring, increased visceral pressure.

The pelvic floor is a thick, compact mass traversed by clefts or vaults, the walls of which are normally in contact, but which open for the passage of material through their channels. The pelvic floor includes all the soft structures which close the outlet of the pelvis. In the human subject the assumption of the erect posture necessitates certain modifications, and here the functions of the pelvic floor are different from those found in animals, in which the long axis of the body is horizontal. In all mammals the closure of the clefts in the pelvic floor is obtained by the action of muscular fibers, and the mass forming the pelvic floor is in its simplest form, composed of muscle, connective tissue, and skin. Hence, the layer is largely sphincteric in action and, therefore, is not very efficient as a support.

In these animals who have assumed the upright position, a further modification of the above simple pelvic floor has occurred. In addition to the layer of sphincteric muscles, another group, supportive in action and attached to the walls of the pelvic cavity, is developed, which forms a wide muscular diaphragm. In the human subject, this diaphragm includes the levatores ani and coccygei muscles. Thus, the highly specialized pelvic floor consists of a compact mass in which two distinct strata of muscles may be differentiated. The upper layer, supportive in function, forms a complete pelvic diaphragm, the inferior, executed for the purpose of control, forms the sphincters which surround the openings of the canals, which perforate the floor in order to reach the exterior. These groups of muscles are different in function and morphology. The sphincter group is derived from the primitive sphincter cloacæ, while the muscles of the pelvic diaphragm, the levatores ani, and coccygei muscles, are traced to the pelvis moving muscles of the lower animals.

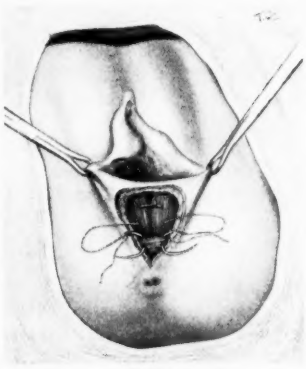


Fig. 4.

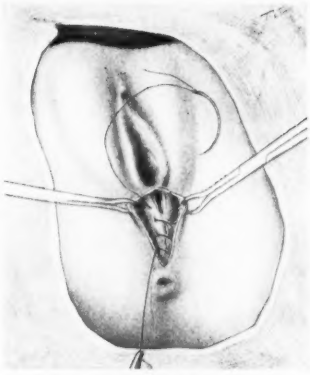


Fig. 5.

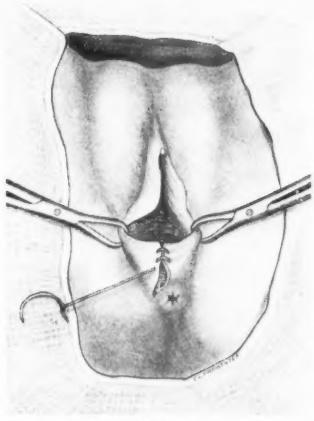


Fig. 6.

Fig. 4. First suture in the levator muscle is tied. The second suture now passed through the lower portion of the levator and a portion of the sphincter ani muscle included before the suture is tied.

Fig. 5. Closure of the trigone. The suture may begin at the lower portion of the trigone as shown, or the first stitch may be inserted at the upper portion just under the skin at the junction of vaginal mucous membrane and vulvar skin. An interrupted or continuous suture may be used.

Fig. 6. Approximation of the skin by continuous over-and-over or mattress suture.

The pelvic floor in the adult human female consists of two segments or planes. The superior plane, or pelvic diaphragm, is composed of the paired levator ani muscle with its two investing fasciæ. The upper one is the rectovesical fascia, or fascia diaphragmatis pelvis superior, and the lower layer is the anal fascia or fascia diaphragmatis pelvis inferior. The inferior plane is limited to the urethral triangle and is known as the urogenital diaphragm or trigone, which is composed of the deep transverse perineal muscle and two layers of fascia.

The superior and inferior layers of the triangular ligament or urogenital diaphragm are homologous with the obturator membrane, and they are a part of the ligamentous wall of the pelvis. The ligament, triangular in shape, extends completely across the pelvic arch from the anterior margins of the ischial tuberosities to near the symphysis pubis, at which point is found the dorsal vein of the clitoris. The two layers of the triangular ligament are fused at their base and apex. The muscular compartment between these sheets is composed of the sphincter urethræ in the anterior portion while the posterior part consists of the deep transverse perineal muscle which is inserted into the perineal center, and acts, to some extent, as a tensor fasciæ. These three layers form a strong musculofibrous plane attached to the bones of the pelvic outlet and placed beneath and parallel to the puborectalis muscle, for which it serves as a support. The triangular ligament is perforated by the urethra and vagina.

The levator ani is a paired muscle which is divided for description into an anterior portion, the puborectalis, and a posterior portion, the iliococcygeus. The puborectalis arises from the posterior face of the body of the pubic bone and is separated from its fellow of the opposite side by an interval of 2 centimeters. The muscle is a broad, flat bundle about 2 centimeters in width and it passes downward and backward along the side of the vagina, where it divides into two portions. The innermost division, the levator vaginæ, continues backward and downward until it reaches the posterior margin of the urogenital trigone. At this point, the muscle turns sharply downward and inward and forms a loop with similar fibers of the opposite side, in the space between the lower end of the vagina and the terminal portion of the anal canal. As the levator vaginæ turns in toward the median line, it gives off from its outer side, a thick bundle of fibers which run into the angle of the sphincter ani muscle. Some of these fibers are continuous in the anterior extremity of the sphincter ani as far as the median line. The outer division of the puborectalis muscle continues backward, passing wholly above the sphincter ani, and joins similar fibers from the opposite side behind anal canal at perineal flexure level.

The iliococcygeus muscle arises in a continuous line from the arcus tendenium musculus levator

ani and from the inner surface of the spine of the ischium. The anterior fibers pass backward and downward, and, at their terminations, they run between the external and internal sphincter ani to reach the fibrous tissue surrounding the anus. The remaining fibers of the iliococcygeus run backward to be inserted into the anococcygeal ligament and the sides of the coccyx. The iliococcygeus muscle is ensheathed by the fascia diaphragmatis pelvis superior and inferior which is continuous at the inner borders of the puborectalis. This fibrous envelop is derived from the obturator fascia.

The pelvic diaphragm may be described as a musculofibrous plate in which muscular action predominates. The puborectalis muscle draws the vagina and rectum forward and compresses them laterally. By virtue of its clamp-like action, the anal canal is reduced to an anterior posterior slit. The levator ani muscle acts as a powerful sphincter, since it surrounds the vagina like a loop. The anus is lifted up over the fæcal mass in defæcation by means of the levator muscle fibers which are inserted into the sphincter ani. A similar function is performed by the muscle in the act of parturition. The levator muscle as a whole supports all the pelvic structures.

The pelvic floor, after removal of the pelvic organs, resembles a funnel, whose sides and posterior walls slope downward toward the anus, which is the lowest point. Anteriorly the pelvic floor is nearly horizontal in the erect posture, the inclination downward being very slight. As a result of this conformation, the intra-abdominal pressure is deflected forward by the sloping surface of the posterior portion of the floor, and inward by the sloping lateral surfaces, so that it falls on the plane surface of the anterior portion of the pelvic diaphragm in the middle line. The interval between the puborectalis extends from the pubic arch backward behind the vagina. In addition, the posterior attachment of the puborectalis muscle is not fixed, so that this portion of the pelvic diaphragm operates under a decided mechanical advantage. Beneath the anterior plane surface of the pelvic diaphragm, the urogenital trigone stretches across the pubic arch as a fibromuscular plate of great strength, supporting the puborectalis, which plays back and forth on it during action, and quickly becomes stretched when the former is torn.

Relaxation of the pelvic floor would be the normal condition in women, were it not for the urogenital trigone. Since the child must pass through the opening in this comparatively unyielding structure, laceration is of frequent occurrence and surgical repair is important. The pelvic floor in woman is perforated by the rectum, vagina, and urethra, and each structure is closely connected to the floor in its passage through it. The rectum and vagina are provided with a sphincter below, while the external sphincter of the female urethra is located in the urogenital trigone.

The sphincter apparatus is derived from the primitive sphincter cloacæ, from which originate the following muscles, the superficial transversus perinei, ischiocavernosus, transversus perinei profundus, sphincter ani externus and internus, bulbocavernosus, and sphincter urethræ. The sphincter ani muscle is of importance in connection with the present study since many of the fibers of the levator ani muscle are inserted and interwoven with it. By means of these fibers, the levator ani is able to elevate the floor of the pelvis.

The external sphincter ani muscle is one-half inch deep, and encircles the anal canal. It consists of three strata: first, a subcutaneous portion which decussates in front of, and behind, the rectum; second, a superficial division which arises by means of a fibrous aponeurosis from the last bone of the coccyx and from the anococcygeal raphe. Passing forward the muscle increases in size and at the posterior margin of the anus it divides into two halves which come in contact on either side with the lower part of the anal canal. At their insertion, some of the fibers become tendinous in the central point of the perineum, others pass superficially toward the skin, while many are continuous with the bulbocavernosus muscle; third, the deep external sphincter ani muscle forms an annular band of some thickness in contiguity with the puborectalis fibers of the levator ani. Its upper margin is not sharply defined because the fibers intermingle to a certain degree with those of the levator ani, and the fibers of the two sides are continuous behind the rectum without being attached to the coccyx. In many cases, the fibers of the deep division of the sphincter ani pass over to the opposite side in front of the anus and are attached to the ascending ramus of the ischium; while in other instances the fibrous tissue constituting the perineal body extends into the deep layer of the sphincter and separates those fibers passing to the ischium from those in contact with the rectum. The fibers which pass to the ischial ramus represent the transversus perinei, and obviously this muscle is closely associated with deep layer of external sphincter and may be regarded as a part of it.

Injuries to the pelvic floor depend on disproportion existing between the size of the passage

and the passenger. In the normal course of labor perineal lacerations occur in about 45 per cent of patients, the majority being primiparæ. Other causes for laceration are rapid expulsion of the child, so that tearing of the perineum instead of stretching results. Again, a faulty mechanism of labor may occur in which the largest circumference of the head passes the perineal ring thus causing a rupture. The use of forceps may be a cause for perineal injury. Rapidity of delivery is probably the most frequent cause for perineal laceration. This condition is particularly seen in cases of precipitate delivery where the head rapidly advances through the birth canal and impinges on the perineum with great force. This mechanism is noted in cases of contracted pelvis, in which strong pains are needed to force the head through the inlet of the pelvis, with the result that the less resistant soft parts are torn. Pressure of the head on the perineal body and lack of retraction between pains, causes perineal injury. The maternal soft parts become anæmic and tense, and tear easily with further advance of the head.

The site and extent of the tear depends on the comparative strength of the structures involved. Superficial injury to the vaginal wall is always to be found in the vaginal sulci on one or both sides, and never involves the posterior vaginal column, a point to be considered in repairing these injuries. The sulcus tear is due to extreme weakness of the vaginal wall on either side of the column. Opinions vary in regard to injuries of the levator ani muscle. Observation of recent tears and dissection of healed ones show that the levator vaginæ muscle is torn in the median line down to the rectal wall and the attachment of the sphincter ani muscle is ruptured to a greater extent on one side, although the fibers inserted into the cornu of the sphincter are torn on both sides. It seems reasonable to expect that this would be the case, since these fibers of the levator vaginæ muscle are exposed equally with the lateral thick portions of the puborectalis to the strain, resulting from the passage of the child. It involves a matter of resistance, and the lateral mass of the puborectalis is stronger than the levator vaginæ muscle.

The firm attachment between the levators and the outer angle of the sphincter is the explanation for complete tears. In such cases, after a laceration of the levator loop, the pressure falls on the sphincter and it gives way. The superficial muscles are torn in various ways. Most frequently the skin tear occurs slightly to the right or left of the median line and the bulbocavernosus and transversus perinei muscles are torn in the same direction. A constant lesion is found, that of abruption of the attachment of the anterior extremity of the sphincter from the bulbocavernosus muscle, thereby allowing the sphincter to retract toward the coccyx.

As a result of the laceration of the fibers of the levator muscle, which are attached to the sphincter, the anal canal prolapses downward and is drawn backward by the sphincter. Such a condition gives rise to the formation of rectocele. Injury to the urogenital trigone is very common and depends on the comparative inelasticity of this supporting structure. It is torn backward, separating with slight retraction, in two portions, which can be easily found at operation. Many cases occur in which the levator muscle fibers as well as the urogenital trigone are torn down to the rectum, while the superficial perineal muscles remain intact. As a result of this situation the pelvic diaphragm becomes weakened, and as intra-abdominal pressure is focused on this torn area, relaxation becomes more marked. At times there is an internal laceration of the levator muscle fibers while the superficial components of the perineum remain intact. The latter are inefficient in supporting the pelvic structures; hence, cystocele and rectocele occur, notwithstanding that the perineum on superficial examination appears normal. If one is familiar with the anatomy of the levator muscle, the diagnosis of internal separation is easily made by palpation of the intervening tissues when one finger is inserted into the rectum and one in the vagina.

The principles which underlie the numerous operations for injury to the pelvic floor are precisely the same as for those which underlie operations for ventral hernia. All surgeons agree that the rational method of operation for ventral hernia is anatomical restoration of the abdominal wall by buried suture. If the pelvic diaphragm and urogenital trigone compose the floor of the female pelvis and if injury to these structures gives rise to a relaxed vaginal outlet with prolapse of the pelvic organs, then the proper method of repair would be to demonstrate these anatomical structures and oppose them accurately by buried suture.

The anatomical type of operation is the only one worthy of consideration. Buried sutures are harmless and enable one to coapt the different planes separately. The puborectalis muscle plays back and forth on the urogenital trigone, therefore, through-and-through sutures including the trigone as well as the muscle would interfere with the free play of the above muscle. Hence, such

sutures should be discarded and layer sutures adopted in all cases.

Laceration of the perineum did not escape the notice of Celsus, but he had no remedy except securing the limbs together and bed rest. Paré recognized the injury and recommended suture. Mariceau did the same, but there is no evidence that sutures were used. The first recorded case of perineal suture was that of Guillemeau. The laceration extended through the perineum and into the anal canal. In repairing this wound, the raw edges were closed by a suture, which was twisted over long needles, placed in the perineum. Roux stated that there were no cases of satisfactory cure, when the perineal laceration was left to nature. His method of repair consisted of approximating the torn edges of the perineum by quilled suture, aided by interrupted ones at a few intermediate points. Other contributors to the study of perineal repair were Rowley in England and Dieffenbach and Osiander in Germany, as well as Emmett and Sims in America.

In 1820, the secondary operation for incomplete laceration was done with a successful termination. Since these early times, many operations have been devised for repair of the relaxed perineal floor.

The operation of perineal repair is done almost entirely by blunt dissection with a minimum of trauma and hæmorrhage. The operation is an anatomical demonstration of the pelvic floor structures, the injuries of which are exhibited and corrected by sight. The field of operation is somewhat restricted; however, by following this technique, the restoration of the perineal floor is easily and quickly accomplished. The essential instruments for this operation are a medium, blunt pointed, pair of scissors, two short tenacula, a knife, needle holder, three straight forceps, and round, pointed, full curve Mayo needles. The needle holder should have broad, strong jaws so that the Mayo needle will be held firmly. If the needle holder does not grasp the needle steadily, it may turn around in the depths of the wound and possibly puncture the rectum. In the following description, reference is made to the right and left side. Such terms apply to the right and left side of the patient, who is in the lithotomy position.

The operation is begun by grasping, on both sides with tenacula, the lateral vulvar structures at the level of the carunculæ myrtiformes. The assistant now pulls the tenacula forward and upward, thereby making the perineum tense. An incision, which begins just below the vaginal fourchette and ends at the fibers of the sphincter ani, is made with a sharp knife in the center of the perineum. The depth of the incision should include the skin and Colles' fascia. The tenaculum on the right side is released while the one on the left side is pulled directly forward. The operator places the left index finger in the left vaginal sulcus and presses backward toward the coccyx. Then the closed scissors are inserted in the upper portion of the median perineal incision and under the vaginal wall of the left side, where they enter the loose connective tissue space between the vaginal wall and the fascia covering the levator ani muscle. The blades of the scissors are then widely opened and the vaginal wall is released from the underlying structures. At this time the left index finger is inserted in this dissected area in order to ascertain that the structures are free and that plenty of room is obtained. The dissection should extend upward to the junction of the lateral and anterior vaginal walls, and posteriorly, down and along the side of the rectum. The left index finger may be inserted in the space between the vaginal wall and the levator ani muscle and by placing the finger below the scissor blade when it is opened, it is possible carefully to separate without injury the levator muscle from the rectum.

The same procedure is carried out on the opposite side. The right levator muscle is nearly always more widely retracted, and there are usually adhesions which render the separation of the vaginal wall from the underlying fascia and muscle somewhat difficult.

By means of this dissection, a large space has been made on both sides between the vaginal wall and the underlying fascia and muscle. Through this aperture, the levator muscles can be easily palpated by thumb and index finger. The left levator is about 2 centimeters deep and extends upward and outward along the outer wall of the opening. The muscle on the right side is palpated at greater depth, since its fascia has withstood more injury with the coincident muscle retraction. Hence, more scar tissue is found on this side.

The tenaculum on the left side is now drawn forward and the operator places the index finger in the interval between the vaginal wall and the levator muscle, pressing backward toward the coccyx. This maneuver places the levator muscle under tension. The needle is passed into the upper third of the space, taking care not to pick up the urogenital trigone which is just in front of the levator muscle. The handle of the needle holder is then brought downward to a vertical position and by inward rotation of the holder on its long axis, the muscle is picked up on the point of the needle. The suture is completed if the structure

obtained is found to be the muscle, which can be recognized by its vertical fibers and reddish color. The same procedure is carried out on the opposite side, but one should remember that the right levator is deeper than its fellow of the other side. The completed suture is now grasped by a forceps and sufficient length is left for tying the knot.

The assistant holds the suture upward and forward, and by this movement the right and left levator muscles are loosely approximated. Subsequent sutures are easily inserted. The needle enters the left muscle and then is brought to the midline, after which it enters the right muscle and the suture is completed. There is no rule for the number of sutures; however, a sufficient number should be used in order to give a proper approximation of the muscles. The number of sutures in the levator muscle varies from three to five.

When the lowest suture is passed through the levator muscle it should include a small portion of the fibers of the sphincter ani. Before tying, this suture should be held taut in order to see that the lowest portion of the levator is evenly approximated, and that a portion of it covers the sphincter and that any dead space is obliterated. There should be no variation in this part of the technique.

The index finger should now be inserted into the vaginal canal and with the thumb on the sutured muscles, the repaired structure can be palpated. The repaired muscles should have the same tension throughout. Additional sutures may be placed where tension is found to be unequal on the two sides. The highest suture in the muscle should not be tight enough to endanger the circulation in that area. If the top suture is too tight, it should be removed, and if too loose another one should be inserted above.

The urogenital trigone is found and sutured in a manner similar to the suture of the levator muscle. The upper part of the trigone just under the vaginal mucosa is about 1.5 centimeters deep, and gradually thins out as it approaches the rectum. It is identified by its thickness and glistening appearance. The first suture of the trigone is important. The needle should pierce the trigone at its upper part just under the skin at the junction of vaginal mucous membrane and vulvar skin. Then the needle should be turned inward toward the middle of the perineum and the suture completed. In this way a large bite of fascia is obtained and, when completed on the opposite side, the levator muscle is sufficiently covered. Before tying, the suture should be held taut, as this demonstrates the amount of fascia in its grasp and in addition displays the remainder of the trigone. Interrupted or continuous sutures may be used.

The skin is closed by a continuous mattress or subcuticular suture of plain catgut. The skin edges should be carefully approximated without too much tension in order to prevent wrinkling and eversion of the edges. A dressing is not needed.

BIBLIOGRAPHY

BRIGGS, H. The female floor. Proc. Roy. Soc. Med. Lond., Sec. Obst. & Gynec., 1920–1921, xiv, 197–206.

CAMERON, J. The fascia of the perineum and the pelvis of the female. J. Anat. & Physiol., 1908, xlii, 438; Fascia of the pelvis. Ibid., 1908, xlii, 112; Real nature of the pelvic fascia. Ibid., 1908, xlii, 106.

CRUVEILHIER. Traité d'anatomie descriptive. 5th ed. Paris, 1874.

DEAVER, J. Surgical Anatomy. Vol. iii. Philadelphia: P. Blakiston's Son & Co.

DELEE, J. Principles and Practice of Obstetrics. 5th ed. Philadelphia.

DERRY, D. Pelvic muscle and fascia. J. Anat. & Physiol., 1907, xlii, 107.

DICKINSON, R. L. Studies of the levator ani muscle. Am. J. Obst., 1889, xxii, 897.

DIEFFENBACH, J. F. Chirurgische Erfahrungen. 1829, i, 64. Sur la rupture de Périneé. J. comp. au Dict. de sc. méd., 1830, xxxviii, 193.

EMMET, T. A study of the etiology of perineal lacerations with a new method for its proper repair. Tr. Am. Gynec. Soc., 1883, viii, 198.

FOTHERGILL, W. The supports of the pelvic viscera. J. Obst. & Gynæc., Brit. Emp., 1908, xvi, 102.

GEGENBAUER, W. Anatomie des Menschen. Leipzig, 1892.

GOLDSPHON, A. Intrapelvic, intravaginal perinorrhaphy without loss of tissue. Medicine. G. S. Davis, 1887.

GUILLEMEAU, J. Les Oeuvres de Chirurgie. Paris: N. Buon, 1612. Livre 3, chapt. 7, p. 354. Quoted Kelly and Noble.

HARRIS, M. L. The repair of old lacerations of the pelvic floor. J. Am. M. Ass., 1899, xxx, 1450.

HART, D. B. The structural anatomy of the female pelvic floor. Atlas of Pelvic Anatomy. Edinburg, 1880.

HENLE, J. Anatomie des Menschen. Leipzig, 1863.

HOLLE, M. Zur Homologie der Muskeln des Diaphragma Pelvis. Anat. Anz., 1895, x, 400.

KEITH, A. Human embryology and morphology. 3d ed. London, 1913.

KOLLMAN, J. Der Levator ani und der Coccygeus bei den geschwænzten affen und den Anthropoiden. Anat. Anz., 1894, ix, 198.

LARTSCHNEIDER, J. Zur vergleichenden Anatomie des Diaphragma pelvis. Sitzungsberichte der Kaiserlichen akademie der Wissenschaften. Wein, 1895, iii, 160.

LUSCHKA, A. Anatomie des Menschen. Berlin, 1863.

MACKENRODT, A. Ueber die Uraschen der Normalen und pathologischen. Lagen des uterus. Arch. Gynaek., 1895, xvii, 393, 421.

MARTIN, E. Der Heftapparat der weiblichen Genitalein. Berlin: S. Karger, 1911.

MCDONALD, E. Lacerations of the perineum. Surg., Gynec. & Obst., 1908, vi, 47–58.

MERIEL, S. Le releveur de l'anus et le relapsus pelvieus. Gaz. hebd. de méd., Par., 1900, v, 1117.

MONTGOMERY, E. Hernia through the pelvic outlet. Surg., Gynec. & Obst., 1913, xvi, 20–27.

MORRIS, H. Human Anatomy. 4th ed., part 5, pp. 1208–1231. Philadelphia: P. Blakiston's Son & Co.

NOBLE, G. A new method of suturing the fascia and levator ani muscle in perineorrhaphy. Am. Gynec., 1903, vol. iii.

OWEN, W. Anatomy of Vertebrates. Vol. iii. London: Longman and Co., 1864.

PARAMORE, R. H. The evolution of the pelvic floor in non-mammalian vertebrates and pronograde mammals. Lancet, 1910, i, 1393; The pelvic floor aperture. J. Obst. & Gynæc., Brit. Emp., 1910, xviii, 95; The supports in chief of the female pelvic viscera. Lancet, 1908, i, 1760; The statics of the female pelvic viscera. Report Royal Free Hospital., Lond., 1918–1925.

PARÉ, A. Opera Ambrosii Parei regis primarii et pariensis chirurgi. Paris: J. Dupuys, 1582. Liber 18, chapt. 27, 698. Quoted by Kelly and Noble.

PATERSON, A. The mechanical supports of the pelvic viscera. J. Anat. & Physiol., 1907, xli, 93–108.

POIRIER and CHARPY. Traité d'anatomie Humaine. Vol. v. Paris: Masson et Cie, 1904.

RETTERER, E. Sur l'origine et l'evolution de la region anogenitale des mammiferes. J. de l'anat. et physiol., 1890, xxvi, 126.

ROUX, A. Memoire sur la restauration du Perinee. Gaz. méd. de Par., 1834, ii, 17.

SAPPEY, E. Traité d'anatomie descriptive. 4th ed. Paris: A. Delabaye, 1898.

SAVAGE, H. Female pelvic organs. New York: William Wood & Co., 1880.

SMITH, E. Studies in the anatomy of the pelvic with especial reference to the fascial and visceral supports. J. Anat. & Physiol., 1907, xlii, 198, 218.

SMITH, W. The levator ani muscle, its structure in man and its comparative relationships. Anat. Rec., 1923, xxvi, 175.

SPALTEHOLTZ, W. Handatlas der Anatomie des Menschen. Vol. iii. Leipzig, 1903.

SUTTON, B. Ligaments, their nature and morphology. 3d ed. London: H. K. Lewis & Co., 1902.

TANDLER and HALBEN. Anatomie und Etiologie des genita Prolapse beim Weibe. Vienna, 1900.

THOMPSON, P. On the arrangement of the fascia of the pelvis and their relationship to the levator ani. J. Anat. & Physiol., 1901, xxxv, 125; Studies from the anatomical department of the University of Manchester. 1906, iii, 200; The myology of the pelvic floor. Manchester, 1889; The pelvic diaphragm: Studies from the anatomy department of Owens College. 1900, ii, 150.

WATKINS, T. Cystocele and high rectocele. Am. J. Obst. & Gynec., 1923, vi, 389.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D.....Managing Editor
ALLEN B. KANAVEL, M.D.....Associate Editor
LOYAL DAVIS, M.D.....Assistant Editor

WILLIAM J. MAYO, M.D.....Chief of Editorial Staff
DONALD C. BALFOUR, M.D.....Associate, Editorial Staff

JANUARY, 1932

BURIED SKIN GRAFTS

THE more recent developments in the transplantation of skin are interesting, especially the burial of grafts beneath the surface, which was introduced by Wilhelm Braun, in 1920. At first only small, thin epithelial "pinch grafts" were employed, which were seized in sharp pointed tissue forceps and plunged out of sight beneath a granulating surface, or placed in little covered cavities prepared for their reception. Later it was found that the entire thickness of the skin could be used, the "small deep grafts" of John Staige Davis, resembling pinch grafts, but cut so as to include the full depth of the cuticle, being particularly adapted to the procedure.

August Bier, of Berlin, who has had much experience with the method, considers its results surprisingly satisfactory, often superior to those of Thiersch grafting, and far better than can be obtained by means of superficial Reverdin grafts. The reasons for success are easily understood: the transplants, being buried, are surrounded on all sides by nutritive material in abundance; they are protected from the infective agents abounding on granulating areas; they are undisturbed by the changing of dressings, by alterations in temperature, or by movements of the extremities, so that they even can be used in ambulatory clinics; they seldom fail to take, even among unhealthy granulations, hence a preliminary preparation may not be necessary; and strangely enough it does not seem to make much difference which side is uppermost. In the course of a week or two the superimposed granulations tend to disappear spontaneously; but when the grafts are too deeply situated for this to occur, the covering may be incised or gently scraped away.

Buried grafts appear to put a new aspect on the possibility of homografting or isografting, that is the grafting from one individual to another, about which there has existed for a long time much controversy. Erich Lexer, for instance, flatly states that "homo-skin-grafting promises nothing and the trouble and suffering of the donor is without avail, the apparently successful cases being based upon faulty or too short observation"; while John Staige Davis says with equal emphasis that "isografting is clinically possible and the results justify its use when autografting is not practicable."

While conceding that Lexer may have been more or less right regarding the older methods, Mannheim recently has achieved some remarkable results with buried grafts, which seem to throw a new light on the problem. With these his success was gratifying and not to be explained away by the growth of epithelium from the margins or from overlooked

islands or chance implantations. His cases were followed up for long periods and the results found to be lasting. He even ventures to predict the success of zoo-grafting by this method, although the possibility of this has long been almost universally discarded.

Instead of using small bits of cuticle, long narrow Thiersch grafts may sometimes be employed to advantage, being woven in and out among the granulations; or an epithelial paste, procured by scraping the moist skin with a knife, can be injected beneath the surface through a large hollow needle. The latter method is particularly useful in hollows and cavities which are difficult of access and where an inferior cosmetic result is unimportant.

"Tunnel-grafting" (McLennan, Keller) apparently is not employed as frequently as its usefulness deserves. In this procedure a number of tunnels are made with an appropriate scalpel, close together, from one side to the other through the tissues completely beneath a granulating area, for instance an ulcer of the leg. Through these passages are inserted narrow, full thickness grafts, their ends projecting upon either side; and owing to their protected and favorable situation good results are said to be obtained, even in ambulatory cases, where more superficial grafting would fail. Colonel W. L. Keller[1] has applied this method, by an ingenious technique, to the lengthening of contracted scars, such as occur about joints following burns and operations.

Contrary to older ideas, it has been found that skin can be successfully transplanted beneath the general cutaneous surface without giving rise to inflammatory reaction, and has thus been employed for a variety of purposes, such as suturing and patching of hernias, the formation of artificial tendons and ligaments, etc. Usually the grafts are prepared by shaving off their epithelial surface, but recently successful transplants of sterilized skin have been made without this preliminary. The procedure is especially appealing because abundant material can be obtained easily from the margins of a wound; but it has not come into extensive use, perhaps from fear of infection, which, however, does not seem to be likely if sufficient care is used.

LEONARD FREEMAN.

[1] Ann. Surg., 1930, June, p. 924.

THE IMPLANTATION OF BILIARY FISTULAS

THE implantation of an external biliary fistula was among the early reconstructive measures employed to re-establish the flow of bile into the gastro-intestinal canal. Czerny[1] performed this operation in 1898. Unfortunately, his priority in the use of the method was lost sight of because his operation was called a "cholangiohepatoenterostomy" when the case was reported by Jordan in 1899 and by Merk in 1902. Merk, in his report of Czerny's operation, clearly described the implantation of an external biliary fistula by a technique which is similar to that employed today. Czerny dissected the fistulous tract through the abdominal wall. This dissected portion was trimmed off, leaving a small projection at the edge of the liver. The portion of the fistulous tract attached to the under surface of the liver was left undisturbed. An opening accidentally made in the jejunum during the dissection was sutured to the capsule of the liver around the biliary fistula. Three days after the implantation of the external biliary fistula, the patient died. At autopsy it was found that the patient had a carcinoma of the ampulla, with metastases in the bile ducts. Czerny in doing this operation

[1] Merk, Adalbert, Beitræge zur Pathologie und Chirurgie der Gallensteine. Mitt. a. d. Grenzgeb. d. Med. u. Chir., 1902, ix, 445-605.

originated the method of implanting an external biliary fistula into the gastro-intestinal tract. Recently there has been considerable interest in this procedure because of the relatively good functional results which have followed its use.

Von Stubenrauch, in 1905, attempted to implant an external biliary fistula. He dissected the fistulous tract down to its communication with the common bile duct, removing it from its attachment to the under surface of the liver. He then implanted it, including its external orifice, into the pylorus. Unfortunately, the fistulous tract necrosed because it had been deprived of its circulation when it was dissected from the liver. Consequently the method failed in this particular instance, and another reconstructive measure was later carried out. An implantation of an external gall-bladder fistula into the pylorus was reported by Mariani in 1912. The patient was well two years after the operation. This was the first implantation following which there was a successful functional result.

No report of an implantation of an external biliary fistula was made in America until 1918, when Eliot recorded an operation performed by F. T. Murphy. The patient had a biliary fistula with a double external orifice. At operation Murphy found that deep within the abdomen, the tract ran parallel and adjacent to the superior portion of the common bile duct. He prepared the inferior portion of the duct for anastomosis, and trimmed off the double portion of the fistulous tract. The remaining portion of the fistula he telescoped into the prepared end of the duct. The patient was well for six months but later became jaundiced and died. Here again it is quite probable that failure resulted because the circulation to the fistulous tract was impaired by dissecting it from the liver. The next case to be reported in America was by Collins in 1919. He operated upon a patient who had an external biliary fistula, following a cholecystectomy and a choledochotomy. Collins found the fistulous tract emerging from between the closely adherent liver and duodenum. He dissected the fistulous tract from the abdominal wall, inserted a rubber drainage tube into its lumen, and implanted the biliary fistula with the projecting tube into the duodenum through a Witzel fistula. Eight months after the implantation, when the case was reported, the patient was well.

Williams implanted an external biliary fistula in 1913, but the operation was not recorded until Lahey reported it in 1923, together with a case of his own in which he had used a similar procedure. Williams did not report the case himself until 1929. His patient at the time of operation was a boy five years of age, who had an external biliary fistula of one year's duration, following the drainage of a cyst of the liver. At the reconstructive operation Williams removed the gall bladder and the cystic duct and then dissected and prepared the fistulous tract for implantation. He incised the duodenum and anastomosed the end of the fistulous tract to the duodenal incision. The new communication functioned successfully; and when Williams reported his case in 1929, sixteen years after the implantation, the patient was well and had had no return of jaundice.

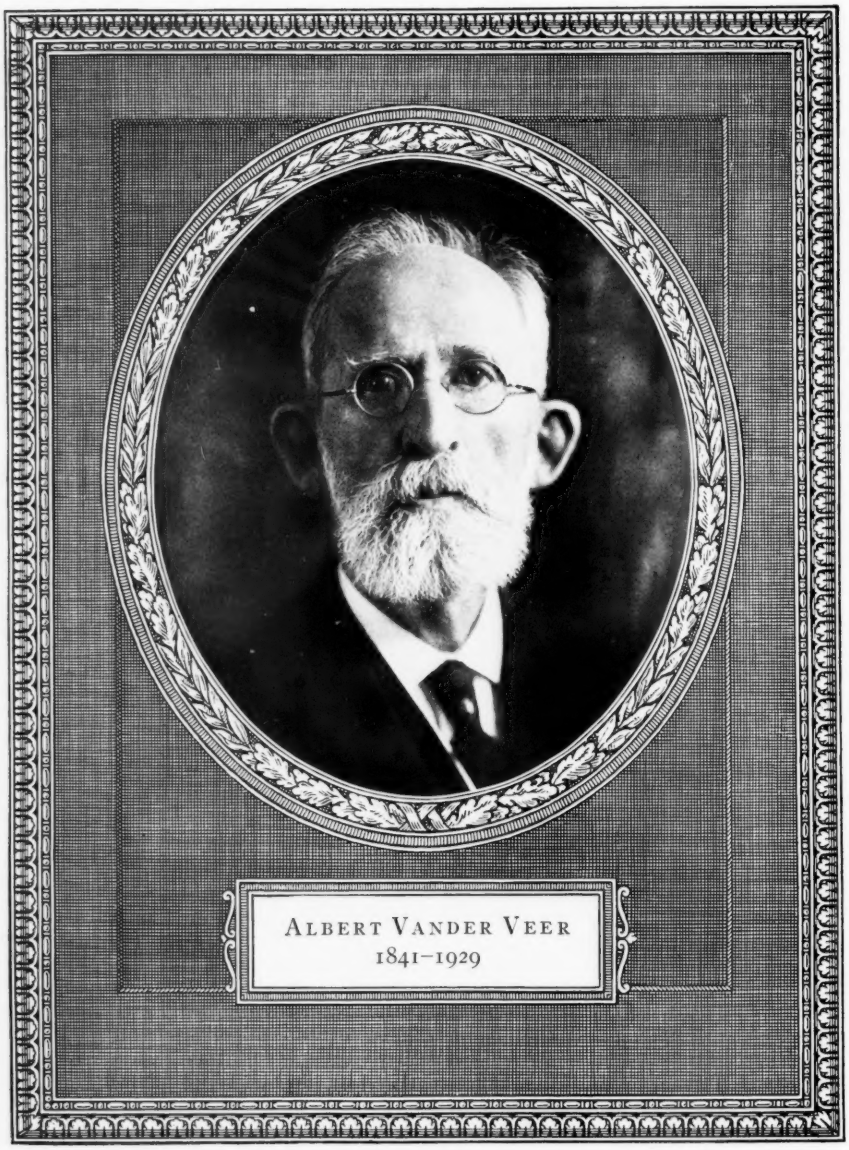
Lilienthal, in 1923, Roith, in 1924, and St. John, in 1926, each reported a case in which an external biliary fistula was implanted into the stomach with satisfactory results. Lilienthal's patient was well two months; Roith's, one month; and St. John's, twenty-one months after operation when the reports were published. Whipple, in 1927, recorded two cases in which death followed the implantation of an external biliary fistula into the stomach. In one case the patient died within twenty-

four hours from cholæmia; in the second case the fistulous tract was impaired during its dissection and a gastric fistula formed, resulting in peritonitis and death. Masson and Walters, at the Mayo Clinic, have each implanted external biliary fistulas, Masson in two instances and Walters in five. The immediate functional results were good in both of Masson's cases, but failure resulted later in one case. Excellent functional results followed the implantation in four of Walter's cases. Recently Lahey has reported a series of ten implantations of external biliary fistulas into the stomach or duodenum. Satisfactory functional results followed six of the operations, failure, two, and death, two.

An indirect implantation of an external biliary fistula into the stomach was recorded by Wilms in 1912. A rubber drainage tube was used to bridge a gap between the fistulous tract and the stomach. The patient was well for four months when she vomited the drainage tube and bile ceased flowing into the gastro-intestinal tract. At a subsequent operation the same method of indirect implantation was again used. The patient was well following the second operation when Wilms reported the case, but Wilms did not state how much time had elapsed.

With implantation of an external biliary fistula an established method of restoring the flow of bile into the gastro-intestinal tract, the technical points which make for its success should be borne in mind when the operation is contemplated. Naturally, the method can be used only in cases in which an external biliary fistula exists or in which a fistula can be purposefully made. The fistula must be well established, well vascularized, and must adequately drain the biliary tract. It is important that the circulation of the fistulous tract remain unimpaired. Therefore, the tract should be cored out of the abdominal wall in a thick cylinder of tissue, the lumen of the tract should not be opened in the dissection, and its attachment to the under surface of the liver should not be disturbed. In preparing the tract for implantation, the external orifice with a small portion of the fistula is trimmed off, leaving a portion of the tract projecting beyond the edge of the liver. A small opening is made in the stomach, duodenum or jejunum, and this opening is sutured to the under surface of the liver near its edge, around the fistula. Where these points have been observed, the functional result has usually been satisfactory. When an external biliary fistula exists, the implantation of the fistulous tract into the gastro-intestinal tract should, because of its simplicity, be considered rather than a more difficult and less feasible method.

EDMUND HORGAN.



ALBERT VANDER VEER
1841–1929

MASTER SURGEONS OF AMERICA

ALBERT VANDER VEER

ON July 10, 1841, Dr. Albert Vander Veer was born in Root, Montgomery County, State of New York. His ancestors on his father's side came from Alkmaar, Holland, in 1659, and settled first at Flatbush, Long Island. Later on some of the family emigrated to the Mohawk Valley, and it is from this branch of the family that Dr. Vander Veer was descended.

His early education was acquired in the district school and very early in his life he manifested his liking for the study of medicine. He began his medical studies with Dr. Simeon Snow, who was a typical country practitioner of the middle part of the nineteenth century. Incidentally Dr. Snow was the father of a very pretty daughter who subsequently became the wife of Dr. Vander Veer. That Dr. Vander Veer was interested in his profession is shown by the fact that he walked three miles every morning from his father's farm to the doctor's office and back again at night. The fall and winter of 1861–1862 was spent as a student of Dr. John Swinburn of Albany, New York, one of the most noted surgeons of his day, and it was undoubtedly this association which turned the young student's later career to surgery. At this time the Civil War had broken out and he was appointed one of the original one hundred medical cadets from the State of New York and stationed at a military hospital in Washington, D. C. The duties of these cadets were those practically of internes, and by working late at night and early in the morning, it was possible for Dr. Vander Veer to attend lectures, from two to eight in the afternoon, at the Columbia Medical College. Immediately upon receiving his degree he was appointed assistant surgeon and later, surgeon, with the rank of major of the Sixty-sixth Regiment New York Volunteers. He was present at Appomatox and at the historic meeting of Grant and Lee, and wrote and spoke frequently of it in his later years. At the conclusion of the War he took a course of lectures in New York City and commenced the practice of medicine and surgery in Albany in May, 1866.

As was the custom in those days he practiced both medicine and surgery. At once he developed a large practice, but early manifested his ability in surgery and gradually withdrew from his medical work though he retained some of his first medical families up to the end of his career. He was appointed professor of general and special anatomy in the Albany Medical College, in 1869, subsequently

being transferred to the chair of surgery which latter position he held until his retirement in 1914.

He was also attending surgeon to the Albany Hospital from 1869 till his retirement. In 1875, when the hospital was about to close owing to its heavy debt, he was largely instrumental in raising that debt so that the institution continued. Again in 1897, when it became apparent that the hospital had outgrown its physical equipment, he headed the group which raised the money for the new hospital, and the new buildings were built largely upon his plans.

He was very fond and proud of seeing his students progress, and nothing gave him greater pleasure than to have one of his old students return and tell him of his success in the practice of medicine and surgery. In 1904, his old students gave him a testimonial dinner at which time they presented him with a loving cup, suitably engraved, which he cherished to the last.

The year 1873–1874 was spent in study abroad. This was the period at which our present surgical technique was being developed and he came back from that trip full of enthusiasm and eager to put the new ideas, which he had learned, in practice, to work. This enthusiasm never left him and he was ever ready to try out new ideas and operations. He was never content to stand still; he was always progressive and kept up with the advances in surgery and, if possible, was a little ahead of them.

He was an omnivorous reader and even up to the last few months of his life he never neglected his medical journals and would try, and very often succeeded, in confounding his sons by asking in a very innocent way about some new medical theory which they had never heard of but which he had just read about.

He was honored by his medical confrères by being elected president of his county and state medical societies, president of the American Surgical Association, president of the American Association of Obstetricians, Gynecologists and Abdominal Surgeons, and, in 1916, was president of the American Medical Association, succeeding to that office by reason of the death of Dr. Rodman, the president for that year.

Dr. Vander Veer was interested outside of his profession in all civic affairs that made for the good of his community, especially that of education. He was a regent of the University of the State of New York, the Educational Department of the State, for 32 years, with the exception of one year, being elected regent first in 1895 and retiring in 1927, due to advancing years. He was vice-chancellor from 1914 to 1922 and then chancellor for a few months, but resigned the position due to impaired hearing. He was an ex-president of the Holland Society of New York and had been decorated with the Order of Orange-Nassau by the Queen of Holland. He was a vice-president of the Albany Institute of Art for over thirty years.

He was of a religious nature and had been an Elder in the First Presbyterian Church for more than 40 years and a commissioner to its General Assembly.

A good share of his later years was passed at his Adirondack Camp where he liked to farm on a small scale and also attend to the cutting of wood and the burning of it in his fire places.

Dr. Vander Veer enjoyed good health up to the end and passed quietly away without pain, at his Albany home December 19, 1929.

He left three sons, all of whom are physicians, and six grandchildren, one of whom is also a physician.

EDGAR A. VANDER VEER.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IN the Mayo Clinic Monograph on *Proctoscopic Examination*,[1] an interesting foreword has been written by William J. Mayo.

The sequence of procedures in examination is shown to be of great importance and the extremely valuable idea of never using a general anæsthetic for proctoscopic examination is heartily agreed with by all proctologists. The psychological control in examinations (usually not mentioned) is prime.

The chapter on diagnosis includes many important procedures. Under "Etiology of Hæmorrhoids" the usual factors are considered, the author believing the most responsible to be infection—an opinion not concurred in by others who are just as certain that physical factors play an equally important part. Is infection necessary in the causation of varicosities in the legs, scrotum, or rectum?

Under "Anæsthesia for Hæmorrhoidectomy" we cannot agree with some of the statements in regard to local anæsthesia. Some operators are able to obtain thorough relaxation and perfect anæsthesia, with no preliminary sedative and no postoperative infection, even in those cases associated with œdema, prolapse, and thrombosis. The reader will note the author's comparison of spinal anæsthesia with sacral block, the latter being the method of choice. A thorough description of block anæsthesia is given, and is nicely illustrated, including some minor but important things which greatly aid in inducing anæsthesia with no complaint from the patient. The chapter on "Hæmorrhoidectomy" stresses many important things, that which should take precedence being that the rectal outlet should never be divulsed, but careful dilation should be used. The method in uncomplicated hæmorrhoids is simple and non-traumatizing. It is agreed that there is no formal operation for all varieties of hæmorrhoids, and that any hæmorrhoidectomy should be followed by an intensive program of postoperative treatment, details being given by the author.

Under "Injection Methods" the admonitions are fine, particularly valuable to the general practitioner, as so much trouble is caused by injection of hæmorrhoids, and other tissues, by men who are inexperienced and unskilled in those methods, no matter what solution is used.

Under "Anal Pruritus" the types, direct and indirect, causes, symptoms, histopathology, and treatment are considered. Methods of treatment are reviewed, then the author's favorite is given, viz., the subdermal injection of 40 per cent ethyl alcohol, which hospitalizes the patient from 2 to 4 weeks, keeping him under observation for an additional 3 or 4 weeks, especially when sloughing occurs, a frequent complication.

The necessary postoperative care is emphasized.

F. E. DAVID.

[1] MAYO CLINIC MONOGRAPHS. PROCTOSCOPIC EXAMINATION AND THE TREATMENT OF HEMORRHOIDS AND ANAL PRURITUS. By Louis A. Buie, B.A., M.D., F.A.C.S. Philadelphia and London: W. B. Saunders Co., 1931.

IN the preface to this second edition of *Urological Roentgenology*,[2] the authors state that they have added a good deal of new material from the literature and from their own clinic, and that they have added chapters on intravenous pyelography and arteriography. In so doing they have increased considerably the value of the book. It is now much more rounded and more complete.

The outstanding feature of this book is still its arrangement as a compendium of clinical urology, upon which skeleton is hung the consideration of roentgenology as a means of diagnosis and prognosis. Therapy has not been specifically included. This arrangement may seem a little boring to some roentgenologists but in the reviewer's opinion is by far the best way of approaching the subject and the only way by which the roentgenologist can become capable of giving intelligent interpretations of his findings. That it has proved acceptable to both roentgenologists and urologists appears to be indicated by the rapid exhaustion of the first edition. The chapter on intravenous urography includes a careful and unprejudiced study of the value of this new procedure and repays careful reading. DAVID M. DAVIS.

CLAIRMONT, Winterstein, and Dimtza of the Zurich University Clinic, representing gradations in rank from the chief down to the assistant have written a book in German, on "The Surgery of Tuberculosis."[3] The book is very systematically arranged and thus avoids completely the fault so frequently found in German texts, namely, the inaccessibility of the material.

The subject of surgery of tuberculosis throughout the entire body is covered. The text is brief, to the point, and, above all, practical. Essentials are discussed and unessentials are omitted. Technique of operations are not given in detail. The authors give

[2] ANNALS OF ROENTGENOLOGY; A SERIES OF MONOGRAPHIC ATLASES. Edited by James T. Case, M.D. Vol. viii—UROLOGICAL ROENTGENOLOGY. By Hugh H. Young, M.D., and Charles A. Waters, M.D. 2d rev. ed. New York: Paul B. Hoeber, 1931.

[3] DIE CHIRURGIE DER TUBERKULOSE. By P. Clairmont, O. Winterstein, and A. Dimtza. Berlin: S. Karger, 1931.

us a résumé of the general consensus of opinion and after that the conclusions they have reached on the basis of their actual experience. The book is written in clear, simple German, which is a blessing for the American surgeon. Material is easily available, the illustrations are excellent, and the type is clear. The point of view of the authors is most sane, leaning to conservatism. RALPH B. BETTMAN.

IN this book[1] on the causation of chronic gastro-duodenal ulcers, Spira attempts to postulate a new physiological principle which explains the occurrence of chronic peptic ulcers as opposed to acute ulcers. The author states: "the acute and chronic ulcer have nothing in common; the acute one never becomes chronic and *per contra* the so called chronic one never assumes the acute form in spite of a recrudescence of activity." Spira explains the formation of a chronic ulcer on the basis of a local irritation (not hydrochloric acid) acting continuously or intermittently, thus accounting for the peculiar clinical story. The causative factor, which is often present for a long period of time before the appearance of the ulcer, is accompanied by gastritis, pylorospasm, and hyperchlorhydria.

The cause of the irritation is built upon the hypothesis that some bile constituents act, in an acid medium, as powerful irritants to the pyloric mucosa. The presence of fat in the stomach delays the evacuation of the stomach contents and stimulates the secretion of bile in the liver and hydrochloric acid in the stomach; at the same time it causes duodenal regurgitation into the stomach (not present under ordinary circumstances during normal digestion) with prolonged irritation of the pyloric mucous membrane and consequent pylorospasm and hypertonus. Fatty acids and soaps form an additional irritation.

In consequence of this theory, the cure depends, almost entirely, upon a suitable diet which must exclude fats. Unfortunately, no detailed plan is presented for either the prevention or cure of ulcer.

No doubt the average reader will be skeptical, nevertheless the sound reasoning employed in the construction of the hypothesis and the uniformly satisfactory clinical results obtained by the author in the treatment of peptic ulcer over a period of 10 years warrant further study of the hypothesis. The medical profession welcomes a new approach to the subject of peptic ulcer. J. A. WOLFER.

THE constantly widening interest in lesions of the anorectal region is being met by a decided increase in the number of contributors to the literature on the subject. When one attempts, as has Dr. Pruitt in his recent book,[2] to discuss every phase of the field in a treatise of 370 pages, some of the chapters will necessarily be somewhat sketchy. The wisdom of dismissing diverticula, for example, in two pages, or injuries and foreign bodies after a consideration on one page each is open to question.

The reviewer would have welcomed a more detailed discussion of the use of low spinal anæsthesia in proctology since the opinion is now widely held that it is particularly well adapted to surgery in this zone, and no mention is made of intravenous medication in anal chancroid, which has in many localities supplanted the old treatment by escharotics and surgery.

The chapters on anatomy, embryology, fistula, and hæmorrhoids are concise and well written and the thirteen pages describing the use of injections in the treatment of piles will intrigue the general practitioner.

The newcomer in the specialty will find in the book a readable introduction to the subject, those already familiar with its principals will credit the author with an extensive knowledge of recent literature, from which he has quoted freely and with a nice discrimination to supplement his own mature experience. CURTICE ROSSER.

IN a volume[3] of 180 pages Ivy and Curtis describe the methods of treatment of fractures of the jaw which in their hands have, during many years' experience, proved most successful. The book will prove of value especially to the surgeon or dentist who, for the first time, is called upon to treat fracture of jaws or even to administer first aid. Too frequently, however, a fractured jaw is improperly treated or neglected for a few weeks, when simple methods such as outlined in this book are no longer applicable. The crux of the treatment of fractures of the jaws is in the reduction of the fracture and its maintenance in normal position by means of wires which hold the teeth in the same relation to each other as they were before the fracture occurred. (This of course, must be realized before the wires are applied.) The manner of application of the wires advanced by the authors is simple and expeditious. It is particularly gratifying to note the contra-indication to open operation in fractures of the neck of the condyles, either with or without dislocation of the head, which is mentioned in the text, but not sufficiently stressed.

The retraction of the posterior fragment by a wire through the angle fixed to the back of the neck or plaster head cap is good. The manner of applying a plaster head cap used to maintain traction in other ways, will be helpful to the uninitiated.

HERBERT A. POTTS.

THE very elaborate treatise[4] on mouth diseases by Goadby contains 460 pages with 145 illustrations, many of them in color and selected from the

[1] THE CAUSATION OF CHRONIC GASTRO-DUODENAL ULCERS: A NEW THEORY. By J. Jacques Spira, M.R.C.S. (Eng.), L.R.C.P. (Lond.). With an introduction by Sir Humphrey Rolleston, Bart., G.C.V.O., K.C.B. New York and London: Oxford University Press, 1931.

[2] MODERN PROCTOLOGY. By Marion C. Pruitt, M.D., L.R.C.P.S. (Ed.), F.R.C.S. (Ed.), F.A.C.S. St. Louis: The C. V. Mosby Company, 1931.

[3] FRACTURES OF THE JAWS. By Robert B. Ivy, M.D., D.D.S., F.A.C.S., and Laurence Curtis, A.B., M.D., D.D.S. Philadelphia: Lea & Febiger, 1931.

[4] DISEASES OF THE GUMS AND ORAL MUCOUS MEMBRANE. By Sir. Kenneth Goadby, K.B.E., M.R.C.S., L.R.C.P., D.P.H. (Cantab.). 4th ed. New York and London: Oxford University Press, 1931.

author's own cases. The actual text is more comprehensive than the title suggests, including many subjects usually considered in a textbook on oral surgery, and discussing the questions of focal infection quite completely. The outstanding feature of the entire work is the thorough background of bacteriological study which permeates every chapter and which possibly accounts for the unusual emphasis placed on vaccine therapy in the last chapter.

In the early chapters, the local diseases of the gingivæ, periodontal membranes, and alveolar process which are of especial interest to the dentist are exhaustively treated in a scientific manner without ignoring the practical clinical requirements. While no particularly new thoughts are presented, the present knowledge of these disturbances of the gums are ably discussed, and various theories are thoroughly analyzed; and the bacteriology, histology, and microscopic pathology of these tissues in health and disease is adequately recorded, without losing sight of the practical problems of diagnosis and treatment.

A chapter entitled "Diseases Originating from Mouth Affections" presents a very clear picture of our present knowledge of the problem of focal infection and the relation of mouth infections to systemic disease. Several chapters on non-dental diseases and lesions which occur in the mouth might well have been written by a dermatologist and an internist in collaboration, and these chapters should be of equal interest to the physician and to the dentist. A chapter on diagnosis in oral diseases stresses bacterial examination and usual laboratory tests, but rather neglects the use of the X-ray film in diagnosis in dental conditions. An American author would undoubtedly have given more attention to this valuable means of diagnosis.

The book is undoubtedly one of the most useful which has appeared, and, although many of the references are dated several years back, the text is thoroughly up to date and should be valuable to either physician or dentist.

CHARLES W. FREEMAN, D.D.S.

KIRSCHNER'S *Operative Surgery*[1] is an excellent exposition of the pre-operative, operative, and postoperative procedures at the surgical clinic at Tuebingen. The fact that the entire responsibility of the clinic is in Kirschner's hands makes the book much more than a mere recital of operative methods. It is a record of procedures which in Kirschner's own experience have proved to be of value. The author does not insist upon his choice of operation, but does say that the surgeon should satisfy himself as to the technique and indications best suited to himself and the problem at hand, and stick to it until a better method is found. He does not favor the vacillation from one operative technique to another under identical circumstances since this tends to inefficiency of the surgeon and confusion of the assistants and nursing personnel; still the surgeon must not be a blind follower of habit. A surgical operation is a problem in anatomy which is the "foundation of every systematically planned operation." It is not necessary, the author says, to have and use all of the instruments and appliances which modern surgery affords. The surgeon should be familiar with the uses and limitations of his tools and should know how to use them to their fullest extent. "In limitation one detects the master." The author's regard for the ward patient who is forced by circumstances to occupy a room with many companions is evidenced by his suggestion that no patient be admitted during the night, that the early cleaning up of the ward be postponed to a more suitable hour, and that the patient should not be awakened early for a bath and temperature.

The first four chapters deal with the more general procedures, such as the examination and preparation of the patient, the general principles of operative technique, and the control of pain, infection, and hæmorrhage. The single chapter on anæsthesia would, in itself, make an excellent short textbook. Ten pages are devoted to the changing of dressings and the after-care of wounds. The instrumental method of one dressing is described and the surgical dressing card illustrated. The last seven chapters deal with specific operative procedures upon the skin, subcutaneous tissues, muscles, tendon, fascia, blood vessels, nerves, bones, joints, and a concluding chapter on amputations. Nearly every procedure described is illustrated with excellent figures, many of which are in color.

Doctor Ravdin is to be congratulated upon the excellency and the smoothness of the translation. The text reads as if it had been written originally in English.

MICHAEL L. MASON.

THE book on *Demonstrations of Physical Signs in Clinical Surgery*[2] is extremely valuable for students and, moreover, can be read with profit by all physicians. The numerous illustrations accurately demonstrate the methods of making a great variety of clinical examinations and tests. The sections dealing with the abdomen are particularly valuable. In these days when laboratory methods seem so involved and so necessary it is very refreshing to read such a fine exposition of the clinical methods of making a diagnosis of surgical conditions.

FREDERICK CHRISTOPHER.

THE book by Cummer[3] on clinical laboratory methods covers a broad field. The twelve chapters include examination of the blood, urine, gastric and duodenal contents, fæces, sputum, and body fluids; blood chemistry; immunology; parasitology; basal metabolism; and bacteriological and miscellaneous

[1]OPERATIVE SURGERY: GENERAL AND SPECIAL CONSIDERATIONS. By Dr. Martin Kirschner. Authorized translation by I. S. Ravdin, B.S., M.D. Philadelphia and London: J. B. Lippincott Company, 1931.

[2]DEMONSTRATIONS OF PHYSICAL SIGNS IN CLINICAL SURGERY. By Hamilton Bailey, F.R.C.S. (Eng.). 3d rev. ed. New York: William Wood and Company, 1931.

[3]A MANUAL OF CLINICAL LABORATORY METHODS. By Clyde Lottridge Cummer, Ph.B., M.D., F.A.C.P. 3d rev. ed. Philadelphia: Lea & Febiger, 1931.

methods. A bibliography is inserted at the end of the book. In a work of this scope obviously not all procedures in common use can be described. Selection is made on the basis of general usage and personal preference. The van den Bergh test for bile pigments in the blood is dismissed as of questionable value; the Hinton test for syphilis is not mentioned; microchemical methods of examination of capillary instead of venous blood are omitted.

The new third edition contains numerous additions, such as the Kline reaction for syphilis, the Newcomer method for determining hæmoglobin content of the blood, the icterus index, and the use of histamine in studying hydrochloric acid secretion by the stomach.

This manual remains one of the best available to the student and laboratory worker.

WALTER H. NADLER.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THEORIE UND PRAXIS DER KREBSKRANKHEIT. By Privatdozent Dr. Felix Mandl. Vienna: Wilhelm Maudrich, 1932.

FORTSCHRITTE AUF DEM GEBIETE DER ROENTGENSTRAHLEN. Edited by Prof. Dr. Grashey. Vol. 37. DIE HARNORGANE IM ROENTGENBILD. By Prof. Dr. Eugen Joseph and Dr. S. Perlmann. 2d rev. enl. edition. Leipzig: Georg Thieme, 1931.

AN INTRODUCTION TO THE LITERATURE OF VERTEBRATE ZOOLOGY; Based chiefly on the titles in the Blacker Library of Zoology, The Emma Shearer Wood Library of Ornithology, The Bibliotheca Osleriana, and other libraries of McGill University, Montreal. Compiled and edited by Casey A. Wood, M.D., LL.D. London: Oxford University Press, 1931.

MATAS BIRTHDAY VOLUME; A COLLECTION OF SURGICAL ESSAYS WRITTEN IN HONOR OF RUDOLPH MATAS, NEW ORLEANS. New York: Paul B. Hoeber, 1931.

RADIOTHÉRAPIE; TECHNIQUE DU DOSAGE EN PROFONDEUR. By Ch. Guilbert. Paris: N. Maloine, 1932.

VEIT'S HANDBUCH DER GYNAEKOLOGIE. Edited by Dr. W. Stoeckel. Vol. iv, 1st half. DIE PHYSIKALISCHE THERAPIE IN DER GYNAEKOLOGIE. Edited by A. Laqueur, W. Rump, H. Wintz. Munich: J. F. Bergmann, 1930.

ANNALS OF ROENTGENOLOGY; A SERIES OF MONOGRAPHIC ATLASES. Edited by James T. Case, M.D. Vol. xiii. GYNECOLOGICAL ROENTGENOLOGY. By Julius Jarcho, M.D., F.A.C.S. New York: Paul B. Hoeber, Inc., 1931.

BIOLOGÍA Y PATOLOGÍA DE LA MUJER; TRATADO DE OBSTETRICIA Y GINECOLOGÍA, publicado bajo la dirección de los Doctores Joseph Halban y Ludwig Seitz. Traducido directamente del original alemán por Joaquín Núnez Grimaldos, con la colaboración técnica del Dr. D. Arcadio Sánchez López. Tomo viii. Madrid: Editorial Plus Ultra, 1931.

MIDWIFERY. By Ten Teachers, under the direction of Comyns Berkeley, M.A., M.D., M.C. (Cantab.), F.R.C.P. (Lond), F.R.C.S. (Eng.), F.C.O.G. Edited by Comyns Berkeley, J. S. Fairbairn, Clifford White. 4th ed. New York: William Wood & Company, 1931.

ASSOCIATION FRANÇAISE POUR L'ÉTUDE DU CANCER. ATLAS DU CANCER. Vols. ix and x. Les Tumeurs de Centres nerveux et des Nerfs périphériques. By Gustave Roussy et Charles Oberling. Fondation Henri de Rothschild. Paris: Librairie Félix Alcan, 1931.

CORRESPONDENCE

THE SURGICAL TREATMENT AND MANAGEMENT OF PHARYNGO-ŒSOPHAGEAL DIVERTICULUM

To the Editor: In the interest of accuracy, may one be permitted to correct a few statements in the paper on "The Surgical Treatment and Management of Pharyngo-Œsophageal Diverticulum" by Dr. McEvers on pp. 525 to 532 of the October issue?

There is no such thing as a "pharyngo-œsophageal" diverticulum. There are "pharyngeal" diverticula, and "œsophageal" diverticula; those to which Dr. McEvers refers are pharyngeal. The name of Zenker must not be attached to these interesting sacs. They were first most accurately described and most perfectly illustrated by Ludlow in a letter to William Hunter in 1764[1]. His specimen of a "Preternatural dilation of, and bag formed in, the pharynx" (please note "pharynx") is still perfectly preserved in the Hunterian Museum at Glasgow. Monro, Sir Charles Bell, Matthew Baillie, and others gave accurate descriptions of the condition. Dr. McEvers speaks of the "Lainer Hackermann point." It is Laimer[2], who was prosector at Graz, and Haeckermann[3], now of Bremen, in whom interest centers. The "point" to which Dr. McEvers refers is not a point but an area. The "Lainer Hackermann point" becomes therefore the "Laimer Haeckermann area." It is not true that in this area the pharyngeal pouches originate. They arise above the sphincter formed by the cricopharyngeus muscle and the Laimer Haeckermann area is not of the slightest importance. These elementary truths were pointed out by me in a paper in the *Lancet* (1927, i, 1061) which unhappily has escaped Dr. McEvers' notice. In the final paragraph of this article I say "Few subjects in surgery are so littered with inaccurate references and incorrect names as this."

[1]Medical Observations and Enquiries, 1767, iii, 85.
[2]Med. Jahrb. Wien. 1888, p. 333.
[3]Thesis dated 1891.

I write not solely to call attention to the facts mentioned, but to encourage my American friends to perform the operation of resection of these pharyngeal pouches in one stage. If a surgeon is competent and has a perfect technique there is really no need whatever for operations in two stages. I have operated upon 15 cases (1 on the right side) and have never had any difficulty in obtaining healing by first intention. MOYNIHAN.

Leeds, England.

To the Editor: To be anatomically correct, these diverticula should be referred to as "pharyngeal" as they arise from the lower posterior wall of the pharynx. They have been referred to so frequently as diverticula of the œsophagus, that the term "pharyngo-œsophageal" as used by E. S. Judd, F. H. Lahey, and others, serves well to establish them as the same as the erroneously named "œsophageal diverticula" in the literature. The same thought applies to Zenker's name which has been so intimately associated with pulsion diverticulum. The proof of Ludlow's priority is well established.

The weak spot or area in the posterior pharyngeal wall, between the pars obliqua and the pars fundiformis of the cricopharyngeus muscle, is the site of origin. The literature has referred to the site of origin variously as the pharyngeal dimple, weak point, and weak spot of the posterior pharyngeal wall, and the Laimer Haeckermann area.

The one stage operation as done a few years ago, resulted in a large mortality rate. This would be tremendously reduced with present day technique; however, a small leak following the one stage operation may result in fatal mediastinitis. The two stage operation, popular in this country, increases the hospital stay but a few days. The second stage may be done 7 days after the first and consists of re-opening the incision down to the neck of the sac and its removal under novocain infiltration. The procedure is exceedingly simple. A. E. MCEVERS.

Rock Island, Illinois.

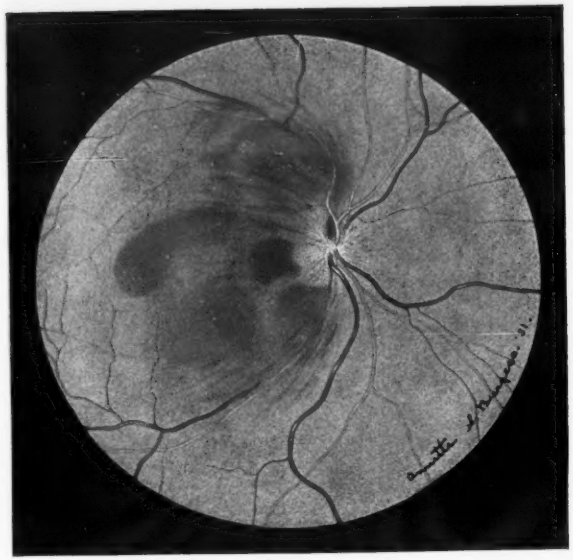


Fig. 1.

Fig. 2.

Hæmorrhagic Retinitis in Vomiting of Pregnancy.—H. J. Stander.